Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 3818-3822
Received: 19-01-2018
Accepted: 20-02-2018

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Chemical and sensory attributes of ghee residue burfi supplemented with corn flour

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Abstract
An attempt was made to utilize ghee residue in the formulation of *burfi* type confection. The formulation was initially standardized for the levels of ghee residue, khoa and sugar levels. On the basis of sensory parameters, 40% ghee residue, 60% khoa and 30g sugar was optimized. The formulation served as control for the subsequent treatment. Further, different levels of corn flour viz. 3%, 6% and 9% were incorporated (by replacing the respective proportions of khoa) in the ghee residue burfi. The developed products were assessed for physico-chemical, colour and sensory parameters. A significant (P<0.05) effect on the pH and titratable acidity was observed at 9% level of CF incorporation, however, at 6% level the value was comparable with the control and 3%. A significant (P<0.05) decline in fat and lactose values were observed at 6% CF level while the sensory scores of burfi for flavour and overall acceptability containing 6% corn flour were higher than the control. Thus, ghee residue burfi, prepared using 6% corn flour is appreciable for its physico-chemical properties and acceptability.

Keywords: burfi, supplemented, chemical, sensory

Introduction
Burfi, an indigenous popular sweet confection, is prepared from khoa, the traditional method of preparation involves heat dessication of khoa with an appropriate content of sugar. The remarkable adaptability of khoa to amalgamate with various ingredients has craved out technologies for development of large burfi varities. There are many varieties of *burfi*, depending on the ingredients mixed with it, *viz*., *besan burfi* (made with gram flour), *kaaju barfi* (made with cashew nuts), and *pista burfi* (made with pistachio) etc., and fruits/ spices added to it, *viz*., *mango burfi*, *coconut burfi*, and *cardamom burfi* etc. (Navale *et al.*, 2014) [13] However, burfi prepared with the combination of ghee residue, khoa and corn flour have not been tried so far. Channelizing dairy by-products to food industries for development of value added dairy products improves plant economy, makes expedient nutrients available to the population and curtail environmental pollution arising from dairy waste. Ghee residue is a by-product obtained during manufacture of ghee. About 30-35% of the milk produced in India is converted into ghee (Gandhi *et al.* 2013) [7]. When cream is heated into ghee, a brownish residue/ghee residue settles down after molten ghee is strained out. It has high nutritional value and is a rich source of lipids, proteins, antioxidants and flavour compounds which warrants for the economic utilization of this important by-product. As ghee residue contains 32-70% of fats, and it is used as a potential substrate for production of lipase (Sahasrabudheet *et al*. 2012) [16]. Ghee residue is the one of the largest by-product of dairy industry. The Ghee residue has been used in food industries for making sweets, bakery products and as a flavour enhancer (Tamine, 2009) [19]. The high nutritional value of ghee residue can be utilized to overcome protein energy malnutrition (PEM) among the undernourished section of the society by suitably incorporating it alongwith khoa in the form of burfi.
Corn flour or maize flour is used in the preparation of nutritious and tasty meals such as snacks, cakes, bread, cookies etc. The main advantage of corn flour over other flours such as wheat, barley, rye or oats, is that corn flour is lacking of gluten so it is suitable for people with celiac disease or gluten intolerance. It is a good source of carbohydrates, minerals (magnesium, phosphorus, iron, selenium and zinc) and some vitamins.
The aim of this study, therefore, was to assess quality and sensory properties of ghee residue burfi enriched with corn flour with the aim of encouraging the use of these under-utilized products in developing value added products with nutraceutical potential.

Material and Methods
The whole fresh and clean milk required for the preparation of khoa was collected from the dairy farm of SKUAST-J, R.S. Pura.

Milk was clarified before use to remove dirt and other extraneous matter. Crystalline sugar, corn flour (weikfield) was purchased from the local market.

Method

Preparation of Khoa

Khoa was prepared from milk as per method of De (2004) [4]. The milk was heated to 80±5 ˚C with vigorous and constant stirring (30-40 rpm). As soon the milk solids started leaving the sides of karahi, stirring-cum-scrapping was continued till the viscous mass reached a semi-solid/ pasty consistency. The pasty mass was then worked up and down to form a pat of single compact mass.

Manufacture of ghee residue

Ghee residue was prepared and collected at Division of LPT, SKUAST-J R. S. Pura. Cream was collected on daily basis and stored in a vessel (initially inoculated with non-specific percentage of dahi) under freezer condition. When quantity of cream was sufficient, it was heated (direct cream method) for separation of ghee and ghee residue. The contents were stirred occasionally to avoid scorching at the base of the vessel. Ghee was filtered by sieve and residue was hand pressed to remove as much ghee as possible.

Processing of ghee residue

The ghee residue was treated as recommended by Prahlad (1954) [15] with slight modifications. Ghee residue was tied in a muslin cloth and then kept in warm soda bicarbonate solution (1%) for 15 minutes to neutralize the acidity.

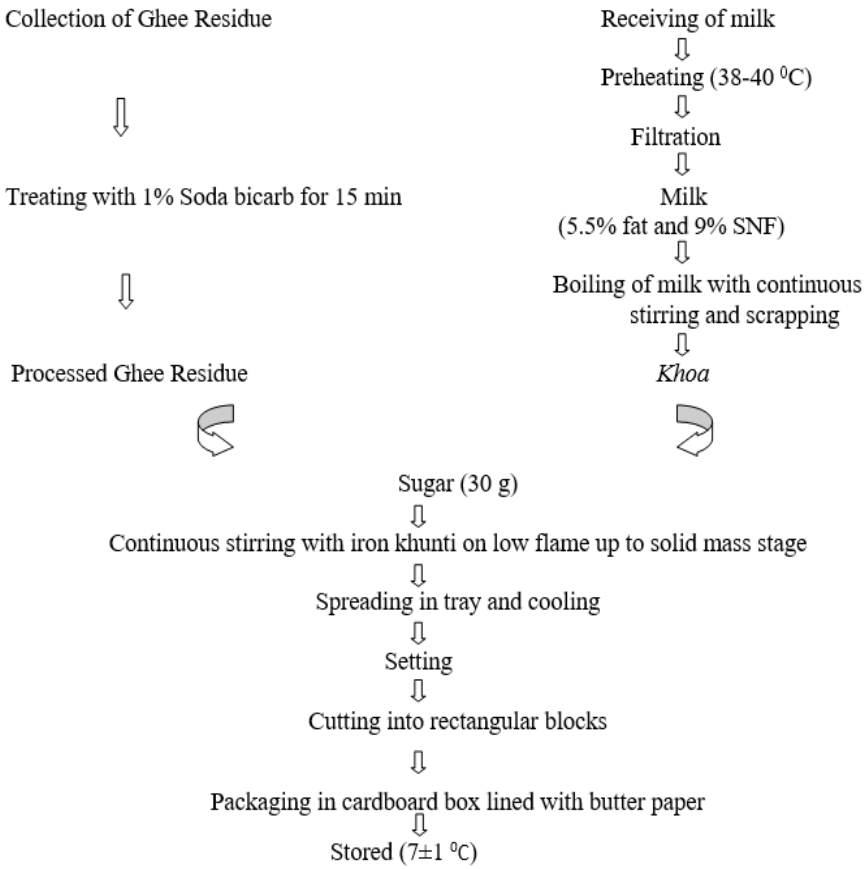
Preparation of control burfi

Freshly prepared khoa was spread over the karahi and crystal sugar @30g was added following which the mixture was worked upon with wooden ladle for 5-10 minutes. The mass was transferred to the greased trays, flattened and allowed to cool under room temperature. It was later cut into the desired rectangular shape.

Preparation of experimental burfi

Experimental burfi was prepared with khoa and ghee residue. Sugar @30g was added. This served as the control for next experiment. Later three different levels of corn flour viz. 3%, 6% and 9% were added to formulate corn flour supplemented ghee residue burfi.

Flow diagram for preparing ghee residue based burfi



Physico-chemical analysis

The pH of ghee residue burfi was measured soon after its preparation by the method of Keller *et al*. (1974) [10] by using a digital pH meter (Systronics Digital pH Meter 803). The proximate components viz., moisture, crude protein, crude fat, total ash contents and Titratable acidity and peroxide values were determined by using standard procedures prescribed by AOAC (1995) [2]. Water activity of the samples was determined using water activity meter (Aqua Lab-Series 3 TE). Lactose percent in the samples was done as per Lane–Eynon volumetric method (Adriano *et al*., 1934) [1]. Total cholesterol in the lipid extracts was determined by adopting the Tschugaeff reaction as modified by Hanel and Dam (1995) [9].

Sensory evaluation of ghee residue burfi

The *burfi* was evaluated for its sensory parameters at regular intervals by semi-trained experienced sensory panel consisting of 7 scientists of the Faculty of Veterinary Sciences and Animal Husbandry on a 9-point hedonic scale with slight

modification (Pal and Gupta, 1985) [14] wherein a score of 1 represented 'dislike extremely' and score of 9 represented 'like extremely'. Water was provided to the panellists for oral rinsing between two sample testing.

Statistical analysis

The results were analysed statistically for analysis of variance and least significant difference tests using the software of statistical package for social sciences (SPSS 16.0) and as per Snedecor and Cochran (1980) [17].

Results and Discussion

Optimization of basic formulation for the preparation of ghee residue burfi

The basic formulation of the burfi was optimised for the levels of ghee residue, khoa and sugar (g). For this purpose, different proportions of ghee residue and khoa viz. 10:90, 20:80, 30:70, 40:60 and 50:50 were used for preparation of ghee residue burfi keeping the fixed level of sugar i.e. 25g (as per standard texts) to optimize the levels of ghee residue and khoa. The 0:100 combination served as control. The products were judged for various sensory attributes. The results are presented in table 1. Results showed that with increase in the levels of ghee residue a non-significant (P>0.05) change was observed upto 40:60 level thereafter, a significant (P<0.05) decrease was observed. This could be attributed to the brown colour of the ghee residue and so could be incorporated upto 40% level. This is in accordance with the study of Borawake and Bhosale (1996) [3], where it was reported that increasing levels of replacement of fat with GR decreased the colour and appearance scores in nankhatai type cookies and sponge cakes. The scores for flavour increased non-significantly (P>0.05) with the increase in the inclusion of ghee residue. This is probably because of the high flavour potential of GR due to the presence of high FFA, carbonyls and lactones (Galhotra and Wadhwa 1991a and 1991b) [5, 6]. Overall acceptability of burfi containing GR: Khoa upto 40:60 level had comparable scores. The overall acceptability scores decreased as the level of replacement increased but the difference was statistically not significant. Similar results were obtained by Subbulakshmi *et al.* (1990) [18], where the mean score obtained for the control was 2.16 which increased to 2.34 and 2.40 in 50 and 100 percent ghee residue substituted biscuits and cakes respectively on a three point scale. Based on above observations, 40% ghee residue and 60% khoa proportion was selected for further studies.

Table 1: Standardization of levels of Ghee Residue and Khoa with fixed percentage of sugar (25g) on the basis of sensory evaluation.

Ghee Residue (%)	Khoa (%)	Colour and Appearance	Body and Texture	Flavour	Mouthfeel	Overall Acceptability
-	100	8.47 ± 0.10^{B}	8.54 ± 0.12^{B}	7.54 ± 0.13	7.26 ± 0.16^{B}	8.16 ± 0.18^{B}
10	90	8.38 ± 0.11^{B}	8.50 ± 0.12^{B}	7.61 ± 0.12	7.13 ± 0.14^{B}	8.09 ± 0.13^{B}
20	80	8.35 ± 0.11^{B}	8.42 ± 0.13^{B}	7.69 ± 0.09	7.04 ± 0.11^{B}	7.98 ± 0.12^{B}
30	70	8.21 ± 0.17^{B}	8.11 ± 0.19^{B}	7.73 ± 0.09	6.96 ± 0.11^{B}	7.92 ± 0.12^{B}
40	60	8.09 ± 0.13^{B}	8.09 ± 0.13^{B}	7.75 ± 0.11	6.85 ± 0.13^{AB}	7.86 ± 0.14^{B}
50	50	7.70 ± 0.12^{A}	7.33 ± 0.18^{A}	7.74 ± 0.13	6.47 ± 0.15^{A}	7.38 ± 0.15^{A}

*Mean± SE with different superscripts in a column wise (upper case alphabet) differ significantly (P<0.05). n=21for each treatment.

Standardization of levels of sugar in Burfi with optimized levels of ghee residue and Khoa

The optimised levels of ghee residue and khoa from previous findings (40:60) was utilised alongwith different levels of sugar i.e. 20, 25, 30, 35 and 40g in the preparation of ghee residue burfi. The products were judged for sensory parameters. The results for sensory attributes of ghee residue burfi with different levels of sugar are presented in table-2. Results showed that increase in level of sugar had a significant (P<0.05) effect on colour and appearance and body and texture upto 30g which later decreased. Also mean values for flavour scores and overall acceptability increased significantly (P<0.05) till 30g. Gothwal and Shukla (1995) [8] found increase in browning intensity with increased level of added sugar in *kalakand, pera and* milkcake. Sugar, apart from giving sweet taste also imparts brown colour to the product by participating in Maillard reaction. Based on the sensory scores, 30g level of sugar was optimised for the development of burfi alongwith ghee residue and khoa (40:60) and taken as control for the subsequent experiments.

Table 2: Standardization of levels of Sugar in Burfi with optimized levels of Ghee Residue and Khoa.

Sugar Levels (g)	Colour and Appearance	Body and Texture	Flavour	Mouthfeel	Overall Acceptability
20	7.21 ± 0.16^{AB}	7.52 ± 0.13^{AB}	7.90 ± 0.14^{AB}	7.34 ± 0.13	7.42 ± 0.13^{A}
25	7.30 ± 0.13^{AB}	7.90 ± 0.14^{BC}	8.07 ± 0.13^{B}	7.47 ± 0.16	7.56 ± 0.13^{AB}
30	7.54 ± 0.13^{B}	8.14 ± 0.18^{C}	8.14 ± 0.18^{B}	7.38 ± 0.15	7.88 ± 0.14^{B}
35	7.26 ± 0.16^{AB}	7.71 ± 0.12^{BC}	7.71 ± 0.13^{AB}	7.35 ± 0.15	7.45 ± 0.13^{A}
40	7.04 ± 0.09^{A}	7.23 ± 0.15^{A}	7.47 ± 0.13^{A}	7.43 ± 0.16	7.28 ± 0.16^{A}

*Mean± SE with different superscripts in a column wise (upper case alphabet) differ significantly (P<0.05). n=21for each treatment.

Evaluation of the composition of burfi formulated with the optimized levels of ghee residue, khoa and sugar

The formulated product containing optimized levels of ghee residue: khoa (40:60) and sugar (30g) will serve as control in the subsequent experiment. The proximate composition of the formulated product has been presented in the table-3

Table 3: Proximate composition of Ghee Residue burfi with optimized levels of khoa, ghee residue and sugar level.

Parameters	%
Moisture	19.45
Protein	23.68
Fat	27.96
Ash	4.06
Lactose	18.79
Ca	0.56
P	0.50

Effect of different levels of corn flour on the physico-chemical properties and sensory attributes of ghee residue burfi

Different levels of corn flour (CF) i.e. (3, 6 and 9%) were utilized for the formulation of burfi by replacing the respective proportions of khoa. The burfi containing 0% CF (from previous study) served as control. The products were evaluated for various parameters. The results are presented in table 4.

Physico-chemical parameters

A significant (P<0.05) effect on the pH and titratable acidity was observed at 9% level of CF incorporation, however, at 6% level the value was comparable with the control and 3%. Increase in pH might be due to denaturation of protein, releasing free amino groups, especially free –SH groups that occurred at higher temperature (Lawrie, 1988) [11]. Being maize proteins which are basic might have resulted in gradual increase in pH with increase in corn flour levels. This is consecutively reflected in decrease in titratable acidty. The mean values for a_w increased non-significantly with the increase in the level of CF incorporation. This might be possibly due to increasing water absorbing property of flour. Narayan and Narasingha (1984) [12] reported that during heat processing of flours gelatinization of the carbohydrates and swelling of the crude fiber occur which leads to increased water absorption. The various levels of CF had a non-significant (P<0.05) effect on TBARS and FFA values.

Table 4: Effect of different levels of corn flour on the physico-chemical attributes of ghee residue based burfi.

Parameters	Levels of Corn Flour (%)			
	0	3	6	9
pH	6.26±0.05^{a}	6.33±0.01^{ab}	6.39±0.02^{ab}	6.41±0.06^{c}
Titratable acidity	0.34±0.02^{b}	0.32±0.02^{ab}	0.29±0.01^{ab}	0.27±0.02^{a}
Water activity (a_w)	0.82±0.02	0.84±0.03	0.86±0.01	0.89±0.02
TBARS	0.79±0.03	0.79±0.03	0.81±0.02	0.80±0.02
FFA	1.128±0.03	1.120±0.03	1.110±0.03	1.116±0.03

*Mean± SE with different superscripts in a row wise (lower case alphabet) differ significantly (P<0.05). n=6 for each treatment.

Proximate parameters

The mean values for proximate parameters are presented in table 5. There was significant increase in moisture percentage with the increase in the level of incorporation of corn flour. This might be attributed to the water absorbing property of the corn flour. The burfi prepared by incorporating 6% and 9% CF had significantly (P<0.05) higher value as compared to control. The mean values for fat and lactose at 3% level was comparable with the control while at 6 and 9% level it was significantly (P<0.05) lower than the control. This could be because of the deffated nature of corn flour used in the formulation of burfi and replacement of khoa levels with the flour during preparation of burfi.

Table 5: Effect of different levels of corn flour on the proximate values of ghee residue based burfi.

Parameters (%)	Levels of Corn Flour (%)			
	0	3	6	9
Moisture	19.53±0.29^{a}	20.18±0.56^{a}	20.67±0.30^{ab}	21.50±0.26^{b}
Crude Protein	23.69±0.28	23.34±0.23	23.05±0.45	22.77±0.42
Fat	27.74±0.24^{c}	27.15±0.33^{bc}	26.59±0.37^{ab}	25.92±0.37^{a}
Ash	3.98±0.07	3.90±0.08	3.83±0.10	3.73±0.10
Lactose	18.65±0.25^{c}	17.94±0.36^{bc}	17.33±0.27^{ab}	16.67±0.22^{a}
Cholesterol(mg/100g)	66.16±2.34	63.81±1.96	63.38±2.31	60.06±2.05
Calcium	0.54±0.01	0.54±0.01	0.52±0.01	0.51±0.02
Phosphorus	0.50±0.02	0.48±0.03	0.48±0.03	0.47±0.02

*Mean± SE with different superscripts in a row wise (lower case alphabet) differ significantly (P<0.05). n=6 for each treatment.

Colour Parameters

The mean values for colour parameters are presented in table 6. A non-significant (P>0.05) increase in the lightness (L*) while decrease in redness (a*) was observed with the increase in the levels of CF. The CF had non-significant (P>0.05) effect on the yellowness (b*) attribute of the burfi. This might be because of the lighter colour of the flour used in the formulation.

Table 6: Effect of different levels of corn flour on the color values of ghee residue based burfi.

Parameters (%)	Levels of Corn Flour (%)			
	0	3	6	9
L (lightness)	32.98±0.22	33.82±0.30	33.59±0.30	33.63±0.43
a* (redness)	5.21±0.07	5.18±0.10	5.01±0.11	5.10±0.08
b* (yellowness)	19.26±0.65	19.30±0.05	19.33±0.05	19.25±0.06

*Mean± SE with different superscripts in a row wise (lower case alphabet) differ significantly (P<0.05). n=6 for each treatment.

Sensory parameters

The mean values for sensory parameters are presented in table 7. The CF had a significant (P<0.05) effect on the sensory profile of the products. There was significant (P<0.05) increase in the scores of colour and appearance and flavour with the increase in level of CF incorporation. Light yellow colour produced upon heating could be attributed to better score for colour and appearance. The score for body and texture declined after 6% level of incorporation. This could be because of increased puffiness which became pronounced at

higher levels. Overall acceptability of burfi made with 6% CF was significantly (P<0.05) higher than the control; however at 9% level of incorporation it was comparable with the control. Higher values of overall acceptability might be due to higher scores for other sensory attributes for the formulation containing 6% corn flour. Hence, 6% corn flour was found optimum in the development of corn flour incorporated ghee residue burfi (CFb).

Table 7: Effect of different levels of corn flour on the sensory attributes of ghee residue based burfi.

Attributes	Levels of Corn Flour (%)			
	0	3	6	9
Colour & Appearance	7.09±0.16^{a}	7.21±0.14^{a}	7.57±0.12^{ab}	7.92±0.19^{b}
Body & Texture	7.38±0.17	7.50±0.17	7.85±0.16	7.45±0.17
Flavour	7.95±0.14^{ab}	8.03±0.12^{ab}	8.29±0.11^{b}	7.82±0.18^{a}
Mouthfeel	7.44±0.16	7.53±0.17	7.68±0.17	7.75±0.16
Overall Acceptability	7.19±0.15^{a}	7.67±0.17^{ab}	7.93±0.17^{b}	7.57±0.18^{ab}

*Mean± SE with different superscripts in a row wise (lower case alphabet) differ significantly (P<0.05). n=21for each treatment.

Conclusion

The study concluded that production of ghee residue burfi has good nurtitional value containing 23.68% protein, 27.96% fat, lactose 18.79%, calcium 0.56% and phosphorus 0.50%. It can be a good source for overcoming protein-energy malnutrition. Further enrichment with 6% corn flour improved the textural value and overall acceptability of the product; above this, acceptability decreases. The study would ensure increase utilization of this underutilized dairy by-product in the development of new value added dairy products.

Acknowledgements

The authors are thankful to the Dean, Directors and Vice-Chancellor of (Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu) for providing necessary funds and facilities for proper execution of research work.

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