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USE OF SKIM MILK RETENTATE POWDER AS EGGSUBSTITUTE IN THE PRODUCTION OF CAKE

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Abstract: Studies were conducted to replace eggs in cake with skim milk retentate powder (SRP) to develop eggless cake. SRP obtained by ultrafiltration technique. Cakes were prepared with SRP as egg substitute and the physical and sensory attributes were studied. Porosity and specific volume and the cake height were comparable to egg containing cake but shrinkage was observed in SRP containing cake when compared to control cake containing eggs. From the studies, it was found that for the preparation of good quality of SRP cake the optimum levels of major ingredients are: 13 per cent SRP, 17 per cent hydrogenated fat, 23 per cent refined wheat flour, 21 per cent sugar, 2.5 per cent baking powder and 22 per cent milk with optimum flavor addition.

Keywords: Skim milk retentate powder, Egg-less cake.

Introduction

There is an increasing demand for bakery foods because of their convenience. Among the bakery products, cakes are important. Keeping in view their good keeping quality and comparatively better nutritive value, baked products including cakes could serve as a carrier of nutrition. The conventional process for cake making uses eggs as an essential ingredient owing to the excellent functional properties of egg proteins. But sometimes the presence of egg is a deterrent to its consumption, due to its typical flavour which is offensive to those who are not accustomed to eggs. Skim milk is one of the important by products of the dairy industry having great potential as bakery ingredients. Skim milk contains all the solids of milk excepting milk fat. It is rich in water soluble vitamins. Skim milk is known to be an excellent source of animal protein of high quality as well as of minerals. Skim milk proteins have very useful functional properties which can be used in making egg less cakes. Hence, an attempt was made to use skim milk retentate powder as egg substitute in cake preparation.

Materials and Methods

Skim milk: Skim milk was obtained by separation of buffalo milk through centrifugal cream separator. The skim milk thus obtained was pasteurized to 72^0C/15 s and cooled to 10^0C and collected for subsequent experiments.

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Cake Ingredients

Refined Wheat Flour: 'Trupti' brand refined wheat flour (maida) manufactured by NEPC Agro Limited, Muzaffar Nagar, was used for making cake.

Vegetable Fat: 'Dalda' vegetable fat (vanaspati) manufactured by Brooke Bond Lipton (India) Ltd. was used

Sugar: Commercial grade cane sugar procured from the Experimental Dairy of the Institute was used after grinding to a powder.

Baking Powder: 'WeikField' baking powder (WeikField Products Co. (India) Pvt. Ltd; Pune) was used as a chemical leavening agent in the preparation of cakes.

Emuslifier and Stabilizer: Tween 80 (polyoxyethylenesorbitan mono-oleate) emulsifier and carboxy methyl cellulose (CMC) stabilizer were obtained from HiMedia Laboratories Pvt. Ltd. Mumbai.

Eggs: Fresh eggs were procured from the local market

Milk: Buffalo milk from Experimental Dairy was used for cake making.

Chemicals: All the chemicals used in this investigation were of AR grade, unless mentioned otherwise.

Equipment

Mixer: Hobart Mixer and Blender manufactured by Hobart Corporation, USA was used to blend, whip and mix the cake batter.

Oven: BPL Microwave and convection heating oven of 40 l capacity was used to bake the cake batter.

Moulds: Borosil crystallizing dishes of size 100 x 50 mm were used as moulds for the preparation of cakes by both convection and microwave baking.

Methods

Manufacture of skim milk retentate by ultrafiltration

Buffalo skim milk was used for the production of skim milk retentate powder using ultrafiltration (UF). UF was carried out as outlined by Patel *et al*. (1991)[1] using a pilot-scale hollow fibre membrane plant (Romicon, membrane type PM 50), supplied by Alfa-Laval, Denmark. Skim milk was pumped by a feed pump from the holding tank into the vertical membrane module. A circulation loop provided with recirculation pump permitted partial recycling of the retentate. The part of the retentate being returned to the feed tank was recycled through the feed pump. The discharge pressure of the feed pump was 0.5 bar

whereas that of the recirculation pump 1.8 bar. The process was continued until required concentration was reached in the skim milk retentate.

Manufacture of skim milk retentate powder

The skim milk retentate prepared by UF was spray dried using Anhydro (Denmark) spray drier, 35 kg water evaporation capacity per hour by maintaining 185^0C inlet and 90^0C outlet air temperature, to get respective powders.

Cake Preparation

Process standardization for the preparation of egg-containing cake

Method was standardized for preparation of cake containing whole egg, refined wheat flour, vegetable fat, sugar and baking powder. The mixture with required quantities of refined wheat flour and baking powder were sifted 8-10 times so as to ensure thorough mixing. Known quantities of sugar and vegetable fat were whipped for 10 min in Hobart blender employing whipping attachment at medium speed. When the beaten mixture attained light whitish yellow colour, liquid whole eggs were added and whipping continued for further 7 min to give a liquid cake batter. The cake batter thus obtained was put into pre-greased glass moulds for baking.

Process standardization for SRP cake preparation

Skim milk retentate powder was used as source of protein in lieu of eggs in cake preparation. The skim milk retentate powder was mixed with milk and whipped for 10 min. The whipped product was then mixed with previously beaten sugar and vegetable fat mixture and whipped further for 10 min. Known quantity of sifted refined wheat flour was slowly added and mixed properly to get liquid uniform cake batter. The cake batter was put into pre-greased mould for baking.

Convection cake baking: The time-temperature combination for cake baking was standardized for convection oven.

Microwave-convection combination cake baking: Baking quality of cake was studied at different levels of microwave power and time in a microwave cum convention oven. Method was also standardized for baking the cake using the combination of both, viz., microwave and convection in the same oven.

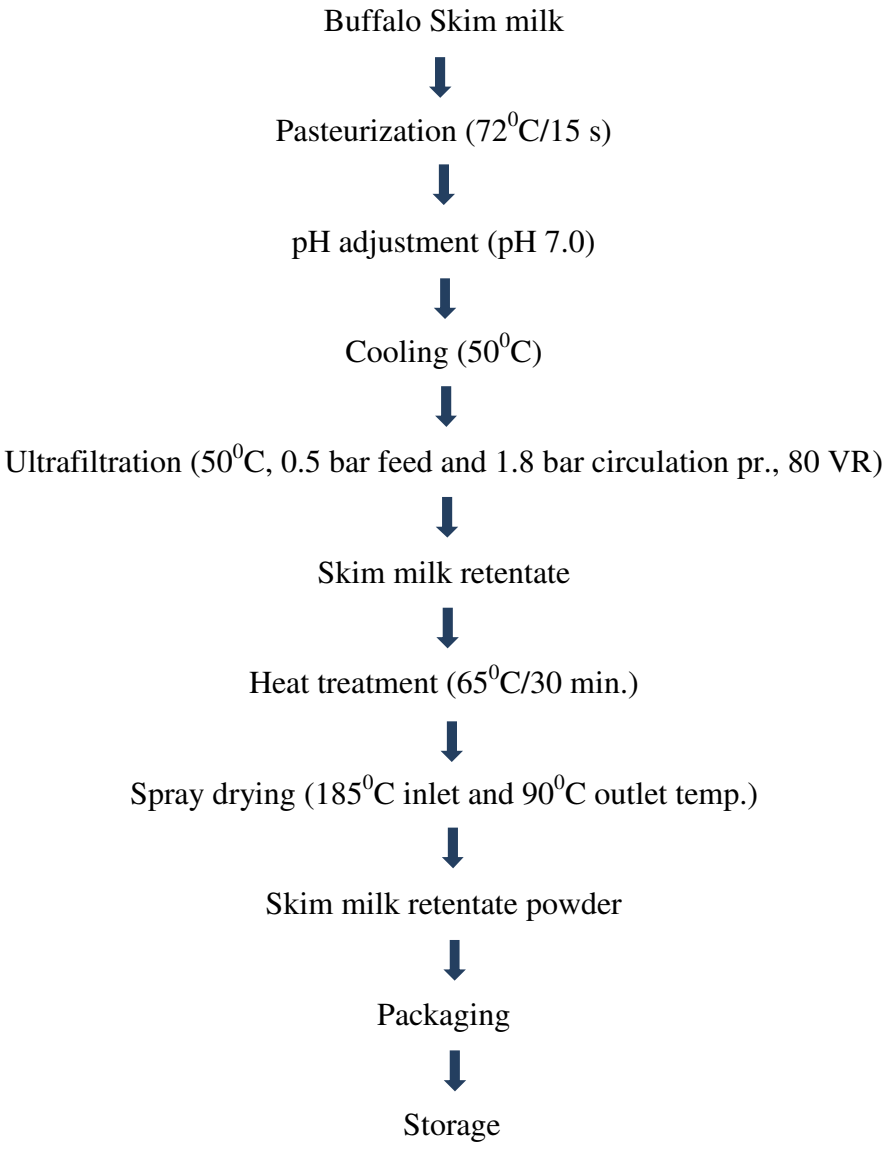
Results and Discussion

Standardization of the Procedure for Cake Making

In the present study cakes were prepared in the laboratory using egg as well as SRP for standardizing the procedure. The egg containing cakes were considered as control for

comparison of physical and sensory characteristics. Since the main aim of the study was to substitute eggs in cake preparation with SRP, based on the results of the functional properties, SRP was substituted for egg in cake with suitable modification in the formulation. The resulting cake batters were baked in both convection and micro-convection combination oven. The time-temperature combination for cake baking was also standardized.

Fig. 1. Flow Diagram for the Manufacture of Skim Milk Retentate Powder (SRP)



Effect of level ingredients on the quality of SRP containing cake

To assess the effect of membrane concentrated and dried skim milk on the cake quality, skim milk retentate powder was used as egg substitute. The results obtained in the experiment are presented in Talbe 2. SRP was added at a level of 9, 13 and 17 per cent of the total cake batter. With the increase in the SRP level from 9 to 13 per cent, less shrinkage and hardness

were observed. Further increasing the SRP level from 13 to 17 per cent had no impact on the cake height and shrinkage, but the hardness increased. The highest sensory scores obtained were at the middle level (13 per cent). This was contradictory to what was observed in egg cake where the hardness decreased with the increasing egg level (Table 1), thus indicating the air cell lamellae in the egg cake tended to become weaker with increasing egg concentration, whereas it became tougher with increasing SRP in the batter. Similar observation with regard to complete replacement of eggs in cakes with a fat-WPC deWit (1984)[2] has replaced eggs completely with a fat-WPC emulsion in cake making and observed that eggs can be replaced in cake making with a fat-WPC emulsions containing the same amounts of fat and protein.

Hydrogenated fat was incorporated at 13, 17 and 21 per cent level. Increasing the level of fat from 13 to 17 per cent, increase in height of the cake, slight reduction in shrinkage and hardness were observed. At 13 per cent, the crust and crumb lacked glossiness, the crumb was hard and the product lacked typical flavor, whereas at 21 per cent fat level, the cake had oily taste sensation and abnormal colour. The maximum sensory scores were obtained at 17 per cent fat level.

Refined wheat flour was tried at the rate of 20, 23 and 26 per cent of the total cake batter. At all levels of addition the shrinkage remained static (0.6 per cent), but the cake height improved with the increasing level of from 20 to 23 per cent. At 26 per cent level, both body and texture and porosity were adversely affected and the cake got lower sensory scores. The sensory scores were maximum fro the cake containing 23 per cent refined wheat flour.

Sugar was tried at 18, 21 and 24 per cent level of the total cake batter. As expected with the increasing the level of sugar, cake height decreased and softness increased. At 24 per cent level the cake had dark brown crust colour and was too sweet. The maximum sensory scores were obtained at 21 per cent sugar level in the cake batter. Compared to egg containing cake, the sugar level required in SRP cake was less which could be due the added advantage of lactose in SRP.

Baking powder was incorporated at 1.5, 2.5 and 3.5 per cent level. Increasing the level of baking powder from 1.5 to 2.5 per cent, reduced shrinkage but increased the cake height. Further increasing the level from 2.5 to 3.5 per cent, no significant improvement in either cake height or reduction in shrinkage was noticed. At 3.5 per cent, the cake had abnormal colour and flavor, whereas at 1.5 per cent the cake was hard and lacked porosity. The maximum sensory scores were obtained at 2.5 per cent level.

Of the three levels of milk viz., 19, 22 and 25 per cent of the total cake batter, cake obtained with 22 per cent incorporation had maximum sensory scores and good physical properties, whereas at 19 and 25 per cent, the cake resulted was hard or soggy.

Hence for the production of good quality SRP containing cake, the recommended levels of ingredients are: 13 per cent SRP, 17 per cent hydrogenated fat, 23 per cent refined wheat flour, 21 per cent sugar, 2.5 per cent baking powder and 22 per cent milk with optimum flavor addition.

Table 1: Effect of level of major ingredients on the quality of egg-containing cake

Ingredient level (%)	Physical Properties S (%)	HT (cm)	H (N)	Sensory Rating Flavour	B & T	Colour	Porosity
Whole Egg							
23	-	4.8	1.74	6.0	7.0	8.0	7.5
27	-	5.5	1.60	8.2	8.3	8.3	8.5
31	-	5.5	1.58	5.0	7.8	7.8	8.4
Hydrogenated Fat							
11	-	5.0	1.84	6.0	6.9	7.0	7.6
16	-	5.5	1.60	8.3	8.4	8.3	8.4
21	-	5.1	1.48	6.1	6.8	7.5	7.7
Refined Wheat Flour							
23	-	5.0	1.38	8.1	7.8	8.0	7.8
27	-	5.5	1.60	8.2	8.3	8.4	8.4
31	-	5.1	1.82	8.1	8.0	8.0	8.2
Sugar							
23	-	5.5	1.77	7.6	7.5	7.2	7.9
27	-	5.0	1.60	8.2	8.2	8.3	8.5
31	-	4.5	1.48	7.8	8.0	6.9	8.0
Baking Powder							
1.3	-	4.7	1.88	6.5	6.2	6.9	7.2
2.6	-	5.5	1.60	8.2	8.3	8.4	8.5
3.9	-	5.6	1.39	5.9	8.2	7.5	8.4

S = Shrinkage, HT = Mean cake height, H = Hardness measured in Instron, B & T = Body and texture

In case of SRP containing cake, shrinkage of the cake was observed at all levels of ingredients addition (Table 2) when compared with egg containing cake (Table 1) where there was no shrinkage at all. This could be due to excellent foaming property of egg proteins. When compared to egg proteins, skim milk proteins have less foaming capacity and foam stability. Puranik and Gupta (2017)[3] observed in a study where whey protein concentrate with 60 per cent protein (WPC 60) containing cake had comparable specific

volume and cake height. They also reported that no shrinkage was observed in WPC 60 containing cake.

Table 2: Effect of level of major ingredients on the quality of SRP-containing cake

Ingredient level (%)	Physical Properties S (%)	HT (cm)	H (N)	Sensory Rating Flavour	B & T	Colour	Porosity
Skim Milk Retentate Powder							
9	0.8	4.7	1.55	7.0	6.9	7.0	6.5
13	0.6	5.2	1.86	7.5	7.7	7.2	7.6
17	0.6	5.2	1.98	7.5	7.0	7.2	7.5
Hydrogenated Fat							
13	0.7	4.9	1.97	6.0	6.1	6.2	6.5
17	0.6	5.2	1.86	7.4	7.6	7.3	7.5
21	0.6	5.1	1.60	6.1	7.0	6.5	7.0
Refined Wheat Flour							
20	0.6	4.8	1.75	7.4	6.7	6.5	6.5
23	0.6	5.2	1.87	7.5	7.6	7.2	7.6
26	0.6	5.1	1.97	7.4	6.1	7.0	6.0
Sugar							
18	0.8	5.2	2.10	7.0	7.0	5.8	7.3
21	0.6	4.5	1.85	7.4	7.7	7.3	7.6
24	0.8	4.0	1.50	6.5	6.5	5.5	7.2
Baking Powder							
1.5	0.9	4.5	1.98	6.8	6.0	5.9	5.5
2.5	0.6	5.3	1.88	7.4	7.6	7.2	7.5
3.5	0.6	5.3	1.51	5.5	-	6.0	7.5
Milk							
19	0.6	4.8	1.92	7.4	6.1	7.0	6.4
22	0.6	5.2	1.86	7.5	7.7	7.3	7.5
25	0.6	5.1	1.59	7.5	6.5	7.3	6.5

S = Shrinkage, HT = Mean cake height, H = Hardness measured in Instron, B & T = Body and texture

Standardization of time-temperature combination for cake baking

In order to achieve proper baking, the time-temperature combination of cake baking was standardized for both convection and micro-convection combination baking.

Convection baking

Time and temperature of baking are important to the quality of cake made by convection baking system. As shown in Table 3, generally lower baking temperature and shorter baking time resulted in under baking as indicated by doughy and moist or soggy texture and light colour, whereas higher temperature and longer time imparted darker colour to the cake crust. The least intense time-temperature combination (170^0C/20 min) resulted in the most

overdone cake. The best time-temperature combination appeared to be 180^0C/25-30 min. as it resulted in a cake that had golden brown crust and without any doughiness. The product was rated the most acceptable.

Micro-convection combination baking

In order to save the time required for baking, microwave-convection combination baking was employed and studies were conducted to optimize the baking conditions in terms of the power level and residence time. The cake batter was first baked by microwave heating followed by convection heating (180^0C/5 min). The results obtained on the product quality are presented in Table 4.At low microwave power level (50), the cake obtained was doughy and moist irrespective of the residence time, whereas at high power (70), the cake had a hard body at all residence times. At medium power (60) with 2.5 min residence time, a cake of acceptable quality with uniform body and texture was obtained.

Table 3: Effect of time-temperature of convection baking on the sensory characteristics of cake

Time (min)	Temperature (^{o}C)		
	170	180	190
20	Doughy, improper baking	Slightly doughy, improper baking	Slightly doughy, moist and improper baking
25	Slightly doughy and moist	Golden brown crust and crumb colour with proper baking	Dark brown crust and crumb colour, dark specks in crumb
30	Moist, dark brown crust and crumb colour	Slightly dark brown crust and crumb colour with proper baking	Very dark brown colour, not acceptable cake

Table 4: Effect of microwave baking on the sensory characteristics of cake

Residence time (min)	Microwave power level*		
	50	60	70
2.0	Highly doughy and soggy	Slightly doughy and moist	Uniform baking but slightly hard body and texture
2.5	Doughy and moist	Uniform baking with acceptable body and texture	Hard body and texture, not acceptable
3.0	Slightly doughy and moist	Uniform baking but slightly hard body and texture	Very hard body and texture

Conclusion

In the preparation of cake sometimes the presence of egg, which is nearly an essential ingredient owing to its ability to increase the number of air cells, thereby contributing to the desired leavening of the product, is a deterrent to its consumption, as it imparts a typical flavor which is offensive to those who are not accustomed to eggs. Hence an attempt was made to prepare eggless cake using skim milk retentate powder as egg substitute. Cakes were prepared with SRP as egg substitute and the physical and sensory attributes were studied. Porosity and specific volume and cake height were comparable to control cake containing eggs. From the studies, it was found that good quality eggless cake can be prepared using skim milk retentate powder as egg substitute with the formulation as 13 per cent SRP, 17 per cent hydrogenated fat, 23 per cent refined wheat flour, 21 per cent sugar, 2.5 per cent baking powder and 22 per cent milk with optimum flavor addition.

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