THE EFFECT OF SWEET WHEY AND ITS DEMINERALISED AND DELACTOSED DERIVATES ON BREAD PROPERTIES

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Summary

This work includes the sweet whey solid and its derivates which are reduced in their some fractions to some extent as a supplementing material for bread. The influence of whey products were examined in the amount that equivalent to 5 % whey solid being one of the lactose or protein content is constant while the other one increases for the bread formulas those are single and supplemented with shortening and SSL.

For the constant lactoşe amount, the increasing whey protein levels decreased dough acidity before oven in being more for shortening and SSL supplemented bread and enhanced crust color pigmentation clearly. While the bread supplemented with shortening and SSL do not give any changes, the breads in single formula showed remarkable increase in both proof time and crumb firmness.

Lactose addition alone gave the best baking results for single bread formula.

For the constant protein amount, the increasing lactose levels prolonged proof time and enhanced the crust color pigmentation to a great extent while decreasing loaf weight and specific volume slightly. The prolonging effect of lactose addition on proof time was prevented by shortening and SSL supplementation.

Introduction

Due to increasing cost of milk and nonfat dry milk in recent years, wide use in bakery products is now being made of milk-replaceres which are functionality equivalent to milk but are lower in cost and more consistent in their properties (Cobb, 1976).

In this study we had sweet whey and some sweet whey products which are reduced in their some fractions completely or partially to provide them functio-

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nality in bakery applications. With those whey products we wanted to see especially the functions of whey lactose and protein alone and together being one of them is constant amount while other one is increasing. Thus we tried to observe wheather or not there is an interaction between these two whey fractions on relating to bread types as in single formula and supplemented with shortening and SSL.

Material and Method

Patent flour which is 11.65% in protein content, 61 % in water asorbtion and 3.5 minutes in mixing time was used. Whey products were supplied from Foremost Food Company-San Fransisco. Their proxiamate compositions and some characteristics were as following.

Trade name	Description	Protein (%)	Lactose (%)	Ash (%)	Moisture (%)
Lactose	Bakery *lactose*	0.1	95.0	0.2	5.0
TekLac	Sweet *whey* solid	12.7	71.3	8.0	4.5
NutriTek-250	Partially *Demineralized*	13.0	74.9	5.5	4.5
Lo-Lac	Partialy *Delactosed*	24.7	55.0	18.7	3.0
Protein-35	Partialy *Demin-Delac*	35.7	54.1	3.0	3.5
Protein-80	Acid whey protein (pH4.7)	80.5	8.0	1.5	4.0

The flour was supplemented with 60 ppm L-ascorbic acid and the malt flour that provides 500 consistent amylolitic activity on amylogram (AACC, 1972). Breads are made in two types according to straight dough procedure has been using in Department of Grain Science and Industry of Kansas State University. The single ingredients were used in Bread type-1 (BT-1) with flour, 2.5% yeast and 2 % salt. Additional 0.5 % SSL and 2 % shortening were used in bread type-2 (BT-2). Sucrose was not used in formulation why not to confuse the browning effects of two sugars, sucrose and lactose.

The constant amount whey fractions are chosen in the proportion based on 5 % whey solid. According to the levels of them based on flour and their approximate lactose, protein and ash involvement are as belows.

Whey products no. Description	The level added into flour (%)	Constant Lactose (%)	İncreasing protein levls(%)	Ash content (%)
0 Control	—	—	—	—
1 Lactose	3.8	3.57	0.004	0.40
2 Whey	5.0	3.57	0.635	0.01
3 Demin	4.8	3.57	0.624	0.26
4 Delac	6.5	3.57	1.606	1.22
5 DeminDelac	6.6	3.57	2.356	0.20

According to constant protein amount, equivalent to that of whey the sequence becomes as below.

Whey products no. Description	The level added into flour (%)	Constant Lactose (%)	Increasing protein levels (%)	Ash content (%)
0 Control	—	—	—	—
1 Protein	0.8	0.635	0.06	0.01
2 DeminDelac	1.8	0.635	0.97	0.05
3 Delac	2.6	0.635	1.43	0.49
4 Demin	4.9	0.635	3.67	0.27
5 Whey	5.0	0.635	3.57	0.40

Apart from the dough pH before oven in and other bread properties, the crumb and crust color of the bread were measured from 6.25 square inch open space under the red light (0-75) for crust, and blue light (24-56) for crumb color by Agtron Reflectance Spektrometer (Tsen, 1980) and the crumb firmness was measured on Instron as gram for 24 and 72 hour shelf-times.

The statistical calculations were done at Kansas State University Computing Center according to he randomized blocks (Steel and Torrie, (1960), and the statistically significant results were described by the aids of Duncan's Multiple Range tests and the figures of interactions ($P < 0.05$).

Results and Discussions

For Constant Lactose Amount Equivalent to that of whey solid

According to Duncan's Multiple Range Tests for variable bread type (Table 1); unsupplemented single bread (BT-1) showed lower dough acidity (before oven in), loaf volume, specific volume, crumb grain score and crust browning, while gives long proof time, the high loaf weight, crumb darkness and firmness compared to dough properties of supplemented bread with SSL and shortening.

Table 2 summarized the effect of increasing protein level against to constant lactose level in equivalent amount to that of whey solid of 5 % as a results of Duncan's Multiple Range Tests. Thus in dough pH before oven in, the increasing amount of the protein decreased dough acidity for the delactosed whey product especially.

When compared to control, the proof time was prolonged by all the whey products due to their lactose content being the largest for delactosed whey which is rich in ash content. However increasing protein did not effect proof time. Except for crust color, in the other bread properties also there was no any chan-

ging effects of increasing protein levels versus constant lactose as well. But as a kind of whey product, lactose and Demineralized-Delactosed whey gave the same loaf volume of control as others are lowering it. All whey products increased the loaf weight when compared with that of control. The results in specifc volume were the similar to that of loaf volume. In crumb grain, lactose was the superior but has the same appearance with control and sweet whey, statistically (Table 2).

In crust color there is an increase in darkening of the crust together with increasing protein content in supplementation adequately, because of the nonenzimatic browning during baking with the interaction between lactose and the alpha amino acid involvement of the whey proteins in Maillard reaction (Hugunin, 1980). When compared to control, whey products gave somewhat yellowness to bread crumb. It might be due to the lactose content dominantly.

In crumb firmness, there was no any ramarkable change by the reason of protein increase versus constant lactose level. (Table 2).

The significant bread type x protein level interaction are gathered in Figure 1. With increasing protein levels, the dough acidity before oven in were decreased being more for bread type-2 with shortening and SSL addition.

Other meaningful interaction were for proof time and crumb firmness, while the bread type-2 does not show any significant change with increasing whey protein, bread type-1 with single formula gave an increase in both proof time and crumb firmness together. Thus, the harmful effect of the increasing protein levels was covered by the effects of shortening and SSL supplementation (Figure 1).

In the loaf volume and spesific volume, lactose addition into single bread formula gave the best results but it was not valid for bread type-2 supplemented with shortening and SSL. Delactosed whey products (no.4) while gives good results for bread type-2, showed the worst response for single bread (BT-1). These results indicates that the unsupplemented breads needs lactose addition addition for better loaf volume. However it can be said that delactosed whey products are not useful for the single bread formulas.

For Constant Protein Amount Equivalent to that of Whey Solid:

The results of the Duncan's Multiple Range Test for variable bread type were summarized in Table 3 that gives the similar results of Table 1, which belongs " constant lactose" experiments. In relation to bread types, it might be said the same things for both Table 1 and 3 as discussed before.

Table 4 gives the effects of increasing lactose levels for constant protein amount, comparing their means by Duncan's Multiple Range Test. According to the results, the dough pH before oven in was increased by Delactosed whey product significantly.

Table 1. Comparison of the means of the data of bread making experiments significant for variable bread type by Duncan's Multiple Range Test ($P<0.05$)[1].

Bread type	N	Dough pH before oven in	Proof time (min)	Loaf volume (cc)	Loaf weight (g)	Spesific volume (cc/g)	Crumb grain (0-10)	Crust color (0-75) (red)	Crum bcolor (24-56) (blue)	Crumb firmness (g) 24/hrs	Crumb firmness (g) 72/hrs
1	12	5.53 a	64.5 a	2300 b	490.0 a	4.70 b	6.62 b	65.9 a	50.3 b	472.7 a	823.0 a
2	12	5.27 b	51.9 b	2872 b	486.9 b	5.90 a	8.54 a	57.7 b	81.1 a	244.5 b	404.7 b

1) Means with the same letter are not significantly different.

Table 2. Comparising of the means of the data of breadmaking experiments significant for variable protein levels for constant lactose by Duncan's Multiple Range Test ($P<0.05$)[1].

Protein levels for constant lactose	N	Dough pH before oven in	Proof time (min)	Loaf volume (cc)	Loaf weight (g)	Spesific volum (cc/g)	Crumb grain (0-10)	Crust color (0-75) (red)	Crumb color (24-56) (blue)	Crum firmness 24/hrs	Crum firmness 72/hrs
0	4	5.30 b	53.8 c	2627 ab	484 b	5.43 a	7.73 ab	82.9 a	69.3 b	348 bc	605 b
1	4	5.28 b	58.0 b	2630 ab	489 a	5.40 ab	8.00 ab	61.5 b	66.7 ab	338 c	611 b
2	4	5.31 b	56.5 bc	2554 bc	491 a	5.20 cd	7.75 ab	62.3 b	65.2 ab	335 c	589 c
3	4	5.33 b	57.3 bc	2534 c	487 ab	5.21 bcd	7.50 bc	63.0 b	65.5 ab	365 b	602 b
4	4	5.60 a	64.3 a	2536 c	490 a	5.18 d	7.38 bc	52.5 c	65.4 ab	355 bc	580 b
5	4	5.59 a	59.8 b	2639 b	491 a	5.38 abc	7.13 c	48.9 c	61.3 b	411 a	697 a

1) Means with the same letter are not significantly different.

Table 3. Comparison of the means of the data of baking experiments significant for variable lactose levels for constant protein by Duncan's Multiple Range Test ($P<0.05$)[1].

Lactose levels for constant protein	N	Dough pH before oven in	Proof time (min)	Loaf weight (g)	Spesific volume (cc/g)	Crust color (0-75 red)	Crumb color (24-56 blue)	Crumb firmnes (g) 24 hrs
0	4	5.30 bc	51.3 c	481.5 c	5.49 ab	77.0 a	69.6 a	339.9 b
1	4	5.30 bc	52.9 c	484.3 bc	5.26 abc	78.9 a	64.9 b	387.9 a
2	4	5.38 b	52.5 c	483.3 c	5.51 a	68.8 b	66.2 b	336.2 b
3	4	5.48 a	52.8 c	484.5 bc	5.45 abc	69.6 b	71.4 a	352.0 ab
4	4	5.33 bc	57.3 b	488.5 a	5.24 bc	58.3 c	69.6 a	373.0 ab
5	4	5.29 c	60.5 a	486.5 ab	5.22 c	60.9 c	63.6 b	355.5 ab

1) The means with the same letter are not significantly different.

Table 4. Comparison of the means of data of baking experiments significant for variable bread type by Duncan's Multiple Range Test. ($P<0.05$)[1].

Bread type	N	Dough pH before oven in	Proof time (min)	Loaf weight (cc)	Loaf weight (g)	Spesific volume (cc/g)	Crumb grain (0-10)	Crust color (0-75) (red)	Crumb color (24-56) (blue)	Crumb firmness 24/hrs	Crumb firmness 72/hrs
1	12	5.52 a	59.3 a	2348 b	485.6 a	4.84 b	6.64 b	75.7 a	53.0 b	463 a	749 a
2	12	5.17 b	49.7 b	2846 a	483.8 b	5.88 a	8.58 a	62.1 b	82.1 a	452 b	402 b

1) Means with the same letter are not significantly different.

The increasing lactose levels prolonged proof time and enhanced the crust pigmentation clearly, and decreased spesific volume and loaf weight slightly.

According to significant bread type x increasing lactose interaction in proof time and crust color (Figure 2), the effects of the increasing lactose levels became different for two bread type. The increasing lactose levels while do not affect the proof time and the crust color to large extent in shortening and SSL supplemented bread (BT-2), for single bread formula (BT-1), raised the proof time and crust color pigmentation remarkably. In this respect, the prolonging effect of lactose on proof time was prevented by shortening and SSL supplementation. On the other side, the lactose proportion in equivalent amount to sweet whey solid alone gave almost same crust browning to that of the 2 % shortening and 0.5 % SSL supplemented bread (Figure 2).

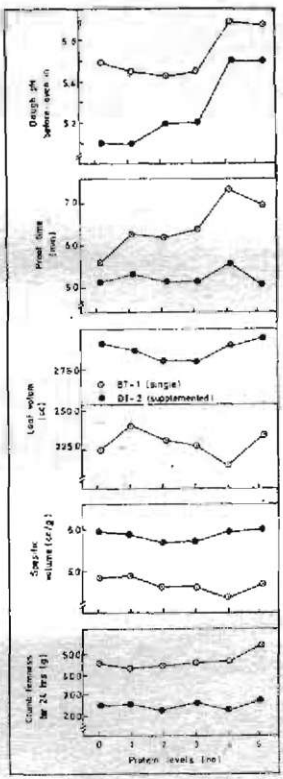

Figure 1. Bread type x protein level interaction in some bread properties

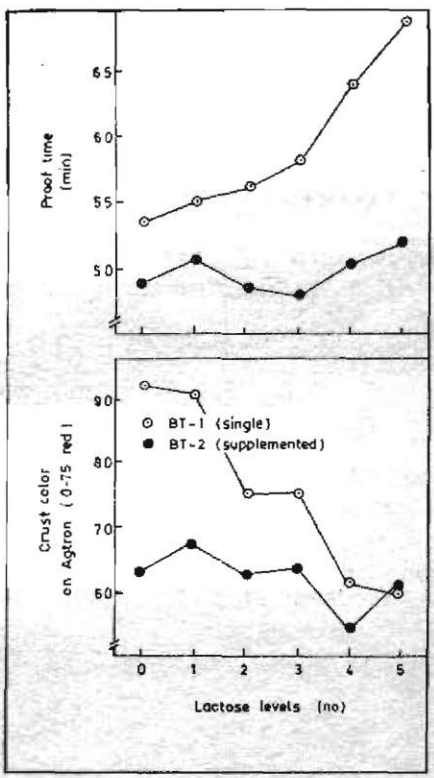

Figure 2. Bread type x lactose level interaction in some bread properties

Özet

Tatlı Peynir Suyu Tozu ile Bazı Demineralize ve Delaktoze Edilmiş Türevlerinin Ekmek Özelliklerine Etkisi

Bu araştırma, bir ekmek katkı maddesi olarak tatlı peynir altı suyu tozu (TPAST) ve bunun türevlerini konu almaktadır. Uygulama % 5 TPAST düzeyine eşdeğerde sabit laktoz veya protein miktarına karşılık diğerinin değişmesi esasına göre düzenlenip, yürütülmüştür.

Sabit laktoz katkısına karşılık, artan protein düzeyi, fırın girişi öncesi hamur pH'sını düşürmüş, şortening ve SSL katkısı etkinliğini artırmış, özellikle ekmek kabuğunun renk intensitesinin artışına önemli düzeyde katkıda bulunmuştur. Yavan formülasyonda ise artan protein katkısı son fermentasyon süresini uzatırken, bayatlamayı hızlandırmıştır.

Yavan formulasyonda en iyi sonucu, yalnız katılan laktoz sağlamıştır.

Sabit protein katkısına karşılık, artan laktoz düzeyi, son fermentasyon süresini uzatırken, ekmek verimi ve spesifik hacmını biraz düşürdü. Şortening ve SSL katkısı bu olumsuz etkiyi giderdi. Her halikarda artan laktoz katkısı ekmek kabuk rengine olumlu etkide bulundu.

Literature

AACC, 1971. Approved Methods, Formerly Cereal Laboratory Methods. 8 th Edd., The Association, St. Paul, Minnesota, USA.

Cobb, S.G. 1976. Alternatives to non fat dry milk. Bakers Digest 50 (2): 42

Hugunin, A.G., 1980. Whey an opportunity for the baking Industry. Bakers Digest 54 (4): 8.

Steel, G.D. and Torrie, J.H. , 1960. Principles and Procedures of Statistics. Mc GrowHill Book Company, New York.

Tsen, C.C., 1980. Yellow Corn flour and meal used as a coloring agent in baking foods. Bakers Digest 59 (4): 24.