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Influence of Some Dairy Powders on the Qualitative Parameters of Bread

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ABSTRACT: Bread, is one of the basic nutrients of Turkish people, is one of the first in providing energy, although it is rich in carbohydrate, and not sufficient in terms of protein, vitamins and minerals, it is suitable for enriching with natural additives. Dairy powder as skim milk powder, yogurt powder, buttermilk powder, colostrum powder, whey protein concentrate powder and lactose powder are obtained by spray drying of some dairy products. The target of this study is to enrich the bread samples with dairy powders and increase the usage of by-products in food systems. For this purpose, different dairy powder (skim milk powder (SMP), butter milk powder (BMP), yoghurt powder (YP), colostrum powder (CP), whey powder (WP) and lactose (L) were used in bread formulations (3%). AACC Method 10.10 was used in bread making with some modifications. Bread volume, weight, specific volume, texture, porosity, symmetry, firmness (after 24 and 72 hours), crust and crumb color properties of the breads and rheological properties (extensograph) of dough samples were investigated. Bread weight, volume, specific volume, texture, firmness ($P<0.01$), symmetry and porosity ($P<0.05$) values were statistically effected by the powder types. While the highest bread volume value was determined with CP, dairy powder addition gave lower bread volume values compared to control bread sample. Besides, CP addition gave desirable bread properties (darker crust color and softer crumb texture). According to rheological properties, the highest resistance to extension and energy values of dough samples was determined with YP addition, while CP addition gave the highest maximum extensibility values. As a consequence, dairy powder form could be used in bread formulations and further studies on dairy by-products usage are recommended.

Keywords: Dairy by-products, Colostrum powder, Yoghurt powder, Butter milk powder, Whey powder, Lactose, Bread.

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INTRODUCTION

Cereal products are the basic nutrient group of the society and they are important part of healthy nutrition since they contain significant nutrients (Demir and Elgün, 2014). Bread does not adequately meet the requirements for many macro or micronutrients (Skrbic and Filipcev, 2008; Demir and Elgün, 2014), therefore researchers explore the utilization of different ingredients and by-products in bread to improve the nutritional and functional properties of bread. In recent years, with the addition of dietary fiber and natural components that have antimicrobial and antioxidant properties, functional of products features are being developed in bakery products industry (Acun and Gül 2014; Gül and Şen, 2017).

Once upon a time, leavened breads that once did not contain any additives other than flour, water and salt, but nowadays, lots of food additives are used in the baking industry (Ribotta, 2001). In recent years, natural additives using is gaining popularity among the consumers as they are becoming more conscious about their diet and health (Asghar et al., 2011). Most bakery products can be easily enriched and supplemented with proteins, minerals and various vitamins at low cost (Indrani et al., 2007). Dairy ingredients and by-products are used in bakery products in various forms to improve their nutritional properties by increasing calcium and protein content and functional properties such as improvement of color, flavor and texture. Especially, lysine, methionine and tryptophan that are essential amino acids increase (Bilgin et al., 2006; Kenny et al., 2000). Dairy by-products affect texture, flavor and color of foods directly (Jacobson, 1997; Kinsella and Morr, 1984). Dairy powders are also good supplement in gluten-free bread formulations and addition of dairy powders resulted in improved volume, good appearance and sensory aspects of the loaves (Gallagher et al., 2003b, Nunes et al., 2009). Using dairy by-products in bakery products, browning reactions occurs giving the wide variety of potential flavours and stability as well as color. Browning is mainly a sugar–aminoacid interaction (Maillard-type reaction), forming brown polymers or melanoidins, during long-term (or very high temperatures) heating of a foodstuff, giving the cooked food its brown colouration (Huyghebaert, 1984; Gallagher et al., 2005). The dairy powders are perfect solution to those who lack immediate access to adequate refrigeration facilities. Dairy powders are produced by extracting water or fat from milk. The aim of converting milk into dairy powders is to convert the raw material to a product that can be stored without substantial loss of quality (Kalyankar et al., 2016).

In this study, the effects of addition colostrum powder (CP), butter milk powder (BMP), skim milk powder (SMP), yoghurt powder (YP), whey powder (WP), lactose (L) on rheological properties of dough and some external and internal properties of bread and possible usage of these products in bakery were investigated.

MATERIALS AND METHODS

Materials

Wheat flour, salt, baker's yeast, dairy ingredients and water were incorporated in to the formulation. The wheat flour was obtained from Hekimoğlu Un A.Ş., Konya, Turkey. Baker's yeast and refined salt were purchased from a local market, and the dairy ingredients such as CP (Colostrum powder), SMP (Skim milk powder), YP (Yoghurt powder), BMP (Butter milk powder), L (Lactose) and WP (Whey powder) were provided by a local dairy.

Methods

Bread ingredients were included 3.0 % yeast, 1.5.0 % salt, 3.0 % dairy powder ingredients (all based on % of flour weight). Amount of water to be added was calculated as farinograph water absorption. All the ingredients were kneading using a Hobart mixer for 5 min. Shaping the kneaded

dough for 30 minutes at 85% relative humidity and left to fermentation. Modified straight dough process (AACC 10-10B) was used (bulk fermentation: 30 + 30 min, proofing: 60 min) by bread making procedure (AACC, 1990). After that bread dough's were baked in an oven (Arçelik ARMD-580 oven, İstanbul, Turkey) for 25 min at 235 ± 2 ºC.

The bread samples were standed and cooled at room temperature then stored in polyethylene bags until analysed. The quality properties of bread samples (loaf weight and volume) were measured immediately after 1 hour of fresh from the oven. Bread volume will be determined on the basis of displacement with rapeseed. Specific volume values (cc g^{-1}) were calculated as dividing the volume by weight of bread samples (AACC, 1990). Lightness, redness and yellowness values of crust and crumb color of the bread samples were measured with chromameter (Konica Minolta Sensing, Inc., Osaka, Japan) as suggested by Francis (1998).

The crumb firmness of bread samples were measured with Test Instrument of Biological Materials at the 24^{th} and 72^{nd} hours after baking in Newton cm^{-2} by texture analyzer using the method of Aydın and Öğüt (1991). In this system sliced bread samples were placed on the movable bottom platform, and were compressed against the stationary platform. The process was carried out at a loading speed of 50 mm / min.

Sensory properties such as symmetry, porosity and texture were achieved after 24 hours. Sensorial characteristics (texture, symmetry and porosity) of bread samples were rated on a 1–10 scale, 5 being the most desirable. Effect of addition dairy products at 3 % level on bread dough were measured by a Brabender extensograph (Brabender/ E model, Duisbug, Germany) using AACC 54-10 methods (AACC, 1990).

Statistical Analysis

Results of this study were performed with TARIST software program by one way analysis of variance. Statistically different means were compared using Duncan's multiple range tests, and a significant level of $P<0.05$ was used.

RESULTS AND DISCUSSION

Bread Properties

Data for the effects of dairy powders on bread properties are presented in Table 1. Bread weight, volume, specific volume, texture, firmness ($P<0.01$), symmetry and porosity ($P<0.05$) values were statistically effected by the powder types.

Among the different dairy powder types, colostrum powder showed the lowest effect on bread weight. Breads with added SMP and BMP had significantly lower bread volumes than the other dairy powders. This similar effect has been reported before (Srivastava and Haridas Rao, 1993). Also, Sert el al. (2016) stated that BMP (56.3%) and SMP (55.5%) gave higher lactose content compared to other dairy powders and the lowest lactose content was also found in colostrum powder (16.1%). High lactose content inhibits yeast activity. Therefore, low volume values might be due to the high lactose content of SMP and BMP. The highest bread volume was obtained with the colostrum powder addition. Colostrum powder has lower lactose content and higher fat and ash content than BMP, SMP and YP (Sert et al., 2016). Colostrum powder with high mineral content positively affected bread yeast activity compared to other powders. Elgün and Ertugay, (1995) stated that high fat content has shown shortening effect and high mineral content improved the bread yeast activity. Also, Gallagher et al. (2003a), Erdogdu-Arnoczky et al. (1996), Gelinas et al. (1995) Kadhharmestan et al. (1998), Kenny et al. (2001) and Axford et al. (1968) reported that the dairy powders (i.e. skim milk powder, sodium caseinate) reduces the loaf volume because of the high protein content. Because, dough slackening and volume-depressing

effects with dairy fractions have been reported frequently. Such fractions include whey proteins (powders or concentrates), casein, and lactose (Erdogdu- Arnoczky et al. 1996).

Table 1. Effects of dairy powders on bread properties[1]

Samples [2]	Weight (g)	Volume (ml)	Specific volume (ml g^{-1})	Texture (1-10)	Symmetry (1-10)	Porosity (1-10)	Firmness (Newton)	
							1. day	3. day
SMP	158.5 ^{a**}	570.0 ^{cd**}	3.6 ^{c**}	6.8 ^{bc**}	8.3 ^{a*}	7.0 ^{bc*}	30.9^{a**}	45.8 ^{b**}
BMP	154.5 ^{b**}	552.5 ^{d**}	3.6 ^{c**}	6.0 ^{c**}	8.0 ^{a*}	7.5 ^{b*}	29.0 ^{a**}	49.1 ^{a**}
YP	149.2 ^{de**}	637.5 ^{b**}	4.3 ^{b**}	7.5 ^{ab**}	7.8 ^{ab*}	7.5 ^{b*}	24.3 ^{b**}	43.5 ^{b**}
CP	148.3 ^{e**}	732.5 ^{a**}	5.0 ^{a**}	7.8 ^{a**}	7.0 ^{c*}	8.3 ^{a*}	14.7 ^{c**}	31.1 ^{d**}
WP	151.3 ^{cd**}	617.5 ^{bc**}	4.1 ^{b**}	7.5 ^{ab**}	7.3 ^{bc*}	7.3 ^{bc*}	27.8 ^{ab**}	45.3 ^{b**}
L	152.4 ^{bc**}	642.5 ^{b**}	4.2 ^{b**}	7.5 ^{ab**}	6.8 ^{c*}	6.8 ^{c*}	24.6 ^{b**}	39.3 ^{c**}

[1] The mean values with different superscript letters in a column are significantly different (P<0.01).
[2] SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose
* P<0.05, ** P<0.01, ns= not significant

The specific loaf volume was 5.0 ml g^{-1} for CP bread. CP addition in bread making gave the highest specific loaf volume.That whey proteins cause the greatest increase in the specific volume of breads has been reported by Nunes et al. (2009). Plessas et al. (2005), reported that the kefir breads had lower specific volumes. In addition, the highest texture values were obtained with addition of CP in breads. Symmetry values ranged 6.8 to 8.3 for bread with addition different dairy powders. Skim milk powder was found to cause an increase in the symmetry of breads. Figure 1 shows the porosity of breads with addition of dairy powders. The important physicochemical parameter, as indicator of bread quality is the porosity of the crumb. The porosity increased in the case of CP addition. The addition of CP resulted a decrease in the bread firmness, the increase in bread firmness with addition CP might be due to reduction in bread volume. There was a negative correlation between loaf volume and crumb hardness (Singh et al., 2003; Gallagher et al., 2003b). Gallagher et al. (2003b) reported that crust hardness was not affected by the addition of dairy powder and remained softer than the control samples.

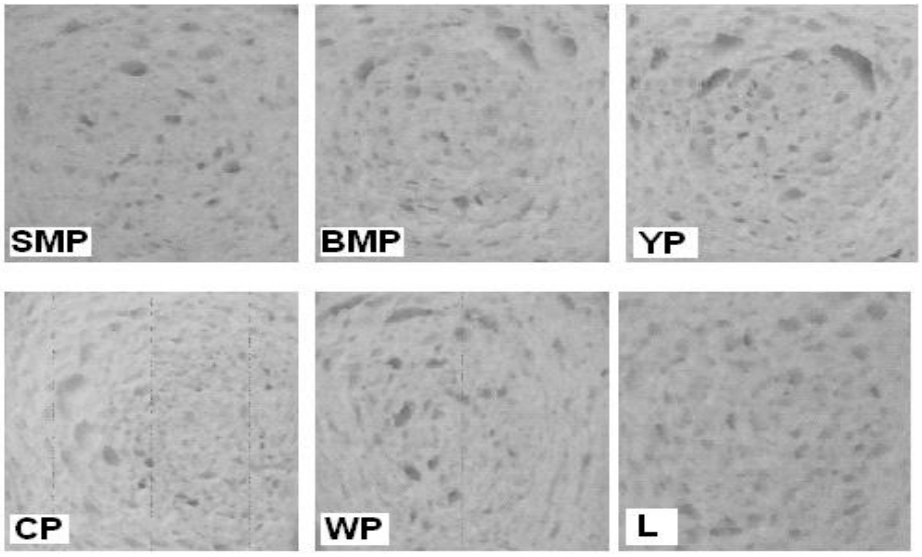

Figure 1 Sample images (photo/8 megapixel) of breads. SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose

Crust and Crumb Color

Table 2 provides information on the crust and crumb color of the breads. The L* scale gives and ranges from 0 black to 100 white; darkness to lightness. The L* values of crust color ranged from 52.84 to 68.28. The SMP breads showed the highest crust L* values and CP breads had the lowest. CP addition gave the darker crust color. Gallagher et al. (2003b) reported that dairy powders gave the darker bread color. These darker colors may be due to the Maillard browning and caramelisation. a* values of crust color ranged from 3.22 to 13.72. YP resulted in a redder color for the crust. The lowest a* values was observed fort the crust of the SMP bread. The b* values of crust was highest for CP bread compared to that of the lowest b* values were observed for the crust of the L and SMP breads. The crumb color of bread with addition different dairy powder ranged from 67.90 to 74.75.

Among the different dairy powders, YP resulted in a lighter and SMP resulted in a darker color for the crumb. These results agreed with the previous study of Gallagher et al. (2003b). The addition of CP decreased the b* values of crumb by descriptively.

Extensograph Properties

The effect of dairy powders on the extensograph properties are shown in Table 3. Resistance to extension values of dough samples enriched with dairy powders at 135 min were varied between 626 and 806 BU, and the highest resistance to extension value was determined with yoghurt powder. The use of colostrum powder increased the extensibility value (147 mm) more than other dairy powders. Also colostrum powder gave the highest bread volume. Şahin et al., (2013) stated that among the extensograph features, only the correlation between extensograph elasticity and bread volume was found significant. The lowest ratio of resistance to extension to extensibility value was obtained with colostrum powder that indicating the high extensibility of the dough.

Table 2. Effect of dairy powders on crumb and crust color of bread samples[1]

Samples[2]	Crust			Crumb		
	L*	***a****	***b****	***L****	***a****	***b****
SMP	68.28 $^{a **}$	3.22 $^{d **}$	29.37 $^{bc **}$	67.90 $^{d **}$	-2.57 ^{ns}	18.59 ^{ns}
BMP	63.99 ^{b**}	9.47 ^{c**}	30.91 ^{b**}	71.62 ^{bc**}	-2.65 ^{ns}	18.46 ^{ns}
YP	52.84 ^{d**}	13.72 ^{a**}	28.50 ^{c**}	74.75 ^{a**}	-2.67 ^{ns}	18.22 ^{ns}
CP	58.59 ^{c**}	11.64 ^{b**}	33.78 ^{a**}	74.49 ^{ab**}	-2.59 ^{ns}	17.35 ^{ns}
WP	57.02 ^{c**}	12.92 ^{ab**}	30.88 ^{b**}	70.99 ^{c**}	-2.46 ^{ns}	18.36 ^{ns}
L	57.27 ^{c**}	12.32 ^{ab**}	29.58 ^{bc**}	71.88 ^{abc**}	-2.51 ^{ns}	17.68 ^{ns}

[1] The mean values with different superscript letters in a column are significantly different (P<0.01).

[2] SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose

* P<0.05, ** P<0.01, ns= not significant

Fig 2 shows the effects of dairy ingredients in bread dough on resistance to extension measured with the extensograph. Concerning Rmax, YP addition promoted the highest increase (976 BU). This is agreement with data given by Bilgin et al. (2006). Baking performance takes important role to predict resistance to extension and extensibility (Anderssen et al., 2004). As a good determinant of flour strength and bread properties, energy value, significantly affected by the addition dairy powders.

Fig 3 shows the effects of dairy ingredients on energy values which measured with the extensograph. YP addition gave the highest energy values. As observed by Bilgin et al. (2006), BMP addition gave the highest energy values. The increase in Rmax and energy values due to the better disulfide linkages of dairy products. There was an increase in dough extensibility with the addition of

CP and the lowest extensibility value was obtained from the dough in which WP was added. Zadow (1981) have found that addition of WPC (whey protein concentrate) in bread formulation caused weaker and less elastic dough.

Table 3. Effects of dairy powders on extensograph measurements[1]

Doughs[2]	R (BU)			Extensibility (Ext.) (mm)			R Ext.-		
Min[3].►	45	90	135	45	90	135	45	90	135
SMP	479 ^{b***}	658 ^{b***}	703 ^{c***}	144 ^{b**}	128 ^{c**}	123 ^{b***}	3.4 ^{a***}	5.2 ^{ab***}	5.8 ^{bc***}
BMP	423 ^{c***}	652 ^{b***}	700 ^{c***}	151^{b**}	138 ^{ab**}	125 ^{b***}	2.9 ^{b***}	4.7 ^{b***}	5.6 ^{c***}
YP	510 ^{a***}	714 ^{a***}	806 ^{a***}	141^{b**}	129 ^{c**}	126 ^{b***}	3.6 ^{a***}	5.6 ^{a***}	6.4 ^{a***}
CP	406 ^{d***}	542 ^{d***}	626 ^{d***}	162 ^{a**}	142 ^{a**}	147 ^{a***}	2.5 ^{b***}	3.8 ^{c***}	4.3 ^{d***}
WP	398 ^{d***}	627 ^{c***}	746 ^{b***}	143 ^{b**}	131 ^{bc**}	117 ^{b***}	2.8 ^{b***}	4.8 ^{b***}	6.4 ^{a***}
L	399 ^{d***}	643 ^{bc***}	721 ^{c***}	144 ^{b**}	132 ^{bc**}	118 ^{b***}	2.8 ^{b***}	4.9 ^{b***}	6.2 ^{ab***}

[1] The mean values with different superscript letters in a column are significantly different (P<0.01) .
[2] SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose
[3] Min: Minute
* P<0.05, ** P<0.01, *** P<0.001, ns= not significant

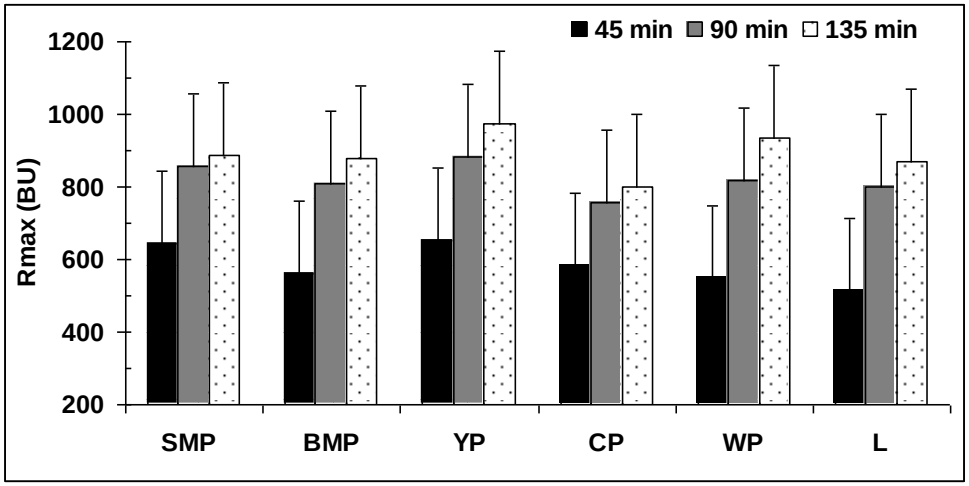

Figure 2. Effects of dairy ingredients on resistance to extension measured with the extensograph. SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose

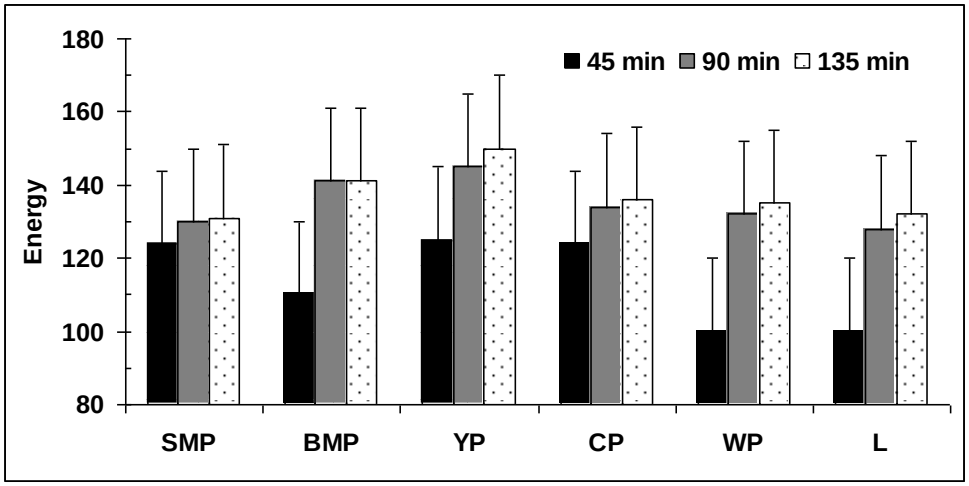

Figure 3. Effects of dairy ingredients on bread dough energy (cm^2) measured with the extensograph. SMP: Skim milk powder, BMP: Butter milk powder, YP: Yoghurt powder, CP: Colostrum powder, WP: Whey powder, L: Lactose

CONCLUSION

Overall, it was found that the addition of colostrum powder improves the lowest bread weight, bread volume and specific volume, and good texture and porosity. The addition of skim milk powder resulted in increased bread symmetry. 1. and 3. day firmness of bread samples were significantly decreased, while colostrum was added in bread formulation. The study of rheological properties of bread dough showed that yoghurt powder gave the highest resistance to extension and energy values. The maximum extensibility values were obtained with colostrum powder. As a result of this study, colostrum powder could be good additive for bread formulations to improve bread quality paramaters due to its functional properties.

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