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INFLUENCES OF SODIUM CASEINATE AND WHEY PROTEIN TO THE RHEOLOGY AND BAKING PROPERTIES OF DOUGH

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Abstract

Dairy ingredients are added to bakery products to increase nutritional and functional properties. Sodium caseinate (SC), untreated whey protein concentrate (WPC) and heat treated whey protein concentrate (WPCHT) were incorporate by replacement into wheat flour, and its effects to dough rheology and the quality of bread were evaluated. 2% SC or 4% SC decreased proof time, increase loaf volume, and improved texture. WPC produced wet and sticky dough, increased proof time, decreased volume, and negatively affected texture. WPCHT improved hanging properties of dough, bread volume and overall baking performance. Incorporation of 10% WPC increased protein content of bread up to 20.2% and also increased the proportion of essential amino acids.

***Key words**: sodium caseinate, untreated whey protein concentrate, heat treated whey protein concentrate, dough rheology, baking performance, protein contain, proportion of amino acids.*

Introduction

Dairy products are traditionally used as components of bread baking formulas to increase water absorption and to enhance dough handling properties and final product quality. Dairy products can also retard moisture loss or delay the staling process, and consequently, extend the shelf life of baked products (Stahel et al, 1983).

Incorporation of dairy protein into wheat products increases not only their protein content, but also improves their nutritional value by increasing the content of the essential amino acids, increases calcium content and has functional benefits including flavor and texture enhancement and storage improvement. Whey is defined as the watery component removed after the setting of the curd in cheese manufactory. Whey contains 93.5% water, 5%lactose, 0.5% minerals, 0.2% milk fat and 0.6-0.8%protein (Huffman, 1996). The major protein fractions of whey are β- lactoglobulin (β-Lg) and α-lactoalbumin (α-La), large globular proteins that make it 80% of the total whey proteins. Undenatured (native) whey proteins are highly soluble. Because of this, they are easily emulsified, able to form foams, and able to form gels when heated. Denatured whey proteins, on the other hand, are nearly insoluble and cannot be emulsified or form foams.

Heat can alter protein conformation and significantly change the functional properties of proteins (Kadharmestan et al, 1998). Harper et al (1984) report that heat treatment of whey proteins changes its structure from native, compactly folded, stable structure that is soluble in water to a denatured, unfolded structure with reduced solubility. The native whey protein interferes with gluten development and, therefore, has negative effects in breadmaking. They can adversely affect the viscoelastic properties and baking quality of dough by significantly decreasing water absorption and interfering with formation of the gluten network. The denaturation of whey protein eliminates this negative effect. Sulfhydryl groups in whey protein (albumin and globulin types) that cause this interference can be altered or lost by a heat treatment (Ashworth et al, 1951). Denatured whey proteins are mostly used as protein supplements in wheat products that have a low protein efficiency ratio (PER) value or are lacking some essential amino acids, such as lysine.

Experimental

Blends of wheat flour and untreated or WPCHT were prepared 24 hr before preparation of bread. Dough containing wheat flour, water and additions of dairy powder were tested using a mixograph to determine water absorption and mixing time. Specific breads volume was measured 2 hr after baking using rapeseed displacement.

Results and Discussions

Overall, SC had a very positive effect on baking properties of dough compared with the control (Kenny et al, 2001). It increased considerably the water absorption (table 1). These data suggest that SC improves the gluten network. Untreated WPC had an overall negative influence on mixograph water absorption of wheat flour and on baking properties. Heat treatment of WPC eliminated these negative effects and dough with WPCHT had superior baking properties compared with dough with WPC. Incorporating of WPCHT increased the optimum water absorption and the mixing time compared to the control, but the mixing time was much shorter than for dough fortified with untreated WPC (table 1). However, addition of WPCHT did not significantly improved baking properties of dough when compared with the control.

Fortification by untreated WPC significantly extended mixing time at both 5 and 10% levels. Treating WPC with heat shortened the mixing time compared to that of untreated WPC (table 1). The negative influence of WPC on dough quality can be explained by the weakening of the gluten network (Kadharmestan et al, 1998). The changes produced were due to the rapid breakdown of gluten after optimum dough development. Zadow et al (1981) postulated that WPC SH groups interfere with the normal SH-SS interchange that occurs during the development of the gluten. These performed in weaker and less elastic dough. Chemical blocking of SH residues resulted in an improvement of the baking characteristics (Zadow et al, 1983). Denaturation of whey protein results in conformational changes and protein unfolding, which may reduce the availability of SH groups for interactions (De Wit et al, 1984).

Wheat flour fortified by SC at 2 and 4% levels produced dough with better handling properties. The dough was more elastic, strength and firmer, had a better stability and gas retention than the control (Kenny et al, 2001). Wheat flour fortified by untreated WPC at 5 and 10% level produce dough with poor handing properties. The dough was wet, sticky, and extremely extensible compared with the control (Kadharmestan et al, 1998). This observation reflected a weakening of gluten during dough mixing, which was caused by the integration between gluten and the active protein components (such as β-Lg and α-

La) in the untreated WPC (Volpe et al, 1975). However, heat-treating WPC restored handing properties of dough fortified with WPCHT.

Table 1. Mixograph absorption and mixing time of wheat flour fortified with dairy products

Sample	Water absorption (%)	Mixing time (sec)
100% wheat flour	70	300
98% wheat flour + 2% SC	73	320
96% wheat flour + 4% SC	78	360
95% wheat flour + 5% WPC	66	390
90% wheat flour + 10% WPC	60	535
95% wheat flour + 5% WPCHT	74	330
90% wheat flour + 10% WPCHT	76	360

Kenny et al (2001) postulated that addition of SC reduced proof time and significantly increased specific bread volume, while untreated WPC decreased specific volume. Independent of incorporation levels bread volume decreased significantly with WPC fortification compared to the volume of the control. The decrease in loaf volume was larger in bread fortified with 10% WPC than in that fortified with 5% WPC (table 2). Wheat flour fortified with untreated WPC produced the smallest loaf volume (Kadharmestan et al, 1998). Bread baked from dough with WPCHT had a significantly higher volume than with untreated WPC (table 2).

Kadharmestan et al, (1998) reported that bread fortified with WPC, either untreated or treated, had a lower brightness of crumb compared to the control. The brightness crumb decreased further when fortification was increased from 5 to 10%.

The protein content of bread increased from 14.8 to 17.6% with 5% WPC fortification and to 20.2% with 10% WPCHT fortification. In addition to the increase in protein content, there were large changes in essential amino acids composition in the protein of bread fortified with WPC. Six amino acids showed significant increases in bread due to the fortification with WPC.

Table 2. Loaf volume of bread from wheat flour fortified with dairy products

Sample	Loaf volume (mL)
100% wheat flour	921.7
98% wheat flour + 2% SC	996.4
96% wheat flour + 4% SC	1120.9
95% wheat flour + 5% WPC	830.0
90% wheat flour + 10% WPC	730.0
95% wheat flour + 5% WPCHT	880.0
90% wheat flour + 10% WPCHT	783.3

Incorporation of 10% WPC by the replacement method increased the protein content of bread up to 20% and increased the proportion of amino acids, including lysine, threonine, isoleucine, leucine, methionine, and valine. The content of lysine, a limited amino acid in wheat products, showed an increase of 64% with 5% fortification of WPC and 98% with 10% fortification (Kadharmestan et al, 1998).

Conclusions

SC improved baking properties of dough. It decreased proof time, increased specific volume, and improved texture. Therefore, SC can be used in dough as a functional ingredient of natural origin and it could reduce the level of synthetic additives required. Dough with 4% SC and the same water content as the control dough did appeared to be more elastic and firmer than the control. This indicated interaction of SC with the gluten to enhance the gluten network in a manner similar to a dough strengthener. This effect combined with the increased water absorption, which makes the dough more expandable, can account for the positive influence of SC on dough quality (Kenny et al, 2001). Good hanging properties of dough were achieved when wheat flour was fortify with 10% WPCHT. WPCHT performed better in dough than the untreated protein. However, the WPCHT does not improve baking performance compared with the control dough without WPC. Incorporation of 10% WPC by the replacement method increased the protein content of bread up to 20% and increased the proportion of essential amino acids.

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