Soy Flour in European-Type Bread

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ABSTRACT

Effect of soy flour, soy protein concentrate, and isolate on dough and loaf properties of breads produced from flour, yeast, salt, and water with no shortening or added improvers was investigated. Wheat flour, rye flour, and mixtures of the two were included in the studies. Three wheat flours, varying in baking quality and extraction, ash content 0.65 and 0.80%, were used; 1.5, 3, and 5% soy products, flour basis, were added. Water absorption increased 3.8-4.7% at the 3% soy level and 6.1-7.3% at the 5% level of soy product addition. Dough development time and stability were increased and dough softening reduced. Dough gassing power increased ca. 7-25%. By using a shorter proofing time, more intensive mixing, and the sponge dough process, loaves only slightly smaller in volume than the control were obtained at the 3% soy level. Panel evaluations scored bread highest with 1.5 or 3% soy flour and that with 3 or 5% soy protein concentrate as lowest, but acceptable. Use of 2% lard as shortening, or 2% lard plus emulsifier, produced soy breads of excellent quality and ca. 25% higher loaf volume than controls.

INTRODUCTION

European-type bread refers to bread produced from flour, yeast, salt, and water without other ingredients, such as nonfat dry milk (NFDM), sugar, or shortening. It is our opinion that enrichment of bread with protein, such as soy products or NFDM, not only has nutritional but economical advantages, owing to better bread protein utilization by the human organism.

Use of high protein components, as bread ingredients, greatly affects loaf volume and general appearance (1-3). Addition of bread improvers, i.e. bromates, stearoyl-2 lactylate (SSL), calcium stearoyl-2 lactylate (CSL), sucroesters, or shortenings, enables the production of good quality high protein bread (4-8). In many European countries, however, these improvers are not allowed or are not used for other reasons, e.g. its effect on bread price (9).

The purpose of the work reported here was to investigate the effect of some commercial soy flours and protein preparations on the physical properties of wheat and rye doughs and on the quality of bread produced according to a poor formula, i.e. one containing no additives.

The following products from Central Soya were investigated: promine F, a neutral soy protein isolate containing ca. 91.5% protein (N x 6.25); promine R, an isoelectric soy protein isolate containing ca. 93% protein (N x 6.25); promosoy 100, a soy protein concentrate containing ca. 67% protein (N x 6.25); soyalose 103, a lecithinated defatted soy flour containing ca. 50% protein (N x 6.25); and textrol, a specially processed soy flour containing ca. 58% protein (N x 6.25). Because of frequent changes of baking qualities of commercial wheat flour, three samples, varying in baking qualities and extraction (ash content 0.65 and 0.80%), were used; 1.5, 3, and 5% of soy products, flour basis, were added. Special attention was paid to textrol, a preparation produced especially for baking.

The physical properties of dough and the gassing power were determined using the amylograph, farinograph, extensograph, and fermentograph and by means of a falling number test. Test bakings, considered as one of the most important indices of dough quality, were made by three different basic methods: the direct (straight dough) method, according to water absorption and dough yield, and the sponge dough method. Several modifications of these methods were applied. Bread quality was determined 24 hr after baking, as well as after 48 and 72 hr.

TABLE I

Effect of Textrol on Viscosity of Flour Suspensions Measured by Hagberg-Perten Method

Percentage of textrol	Falling number (sec) Wheat flour 1	Wheat flour 2
Control	210	122
1.5	219	125
3.0	226	127
5.0	232	132

EFFECTS OF SOY PRODUCTS

The effect of soy products on gluten qualities was investigated after three different periods of dough mixing– 5, 10, and 15 min. Neither the amount of soy products nor the period of dough mixing affected the amount of wet gluten. The quality of wet gluten, however, changed. Gluten became more firm and compact, and its extensibility was reduced. This effect is of great practical importance, especially for weak flours with soft glutens. In the case of strong flours, however, the addition of soy products would not be recommended, owing to the reduction of gluten extensibility.

The effect of 1.5, 3, and 5% textrol on the viscosity of wheat and rye flour suspensions expressed in falling number is presented in Table I.

As may be seen from the above data, addition of textrol increased the viscosity of the flour suspensions, but its effect was less distinct in the case of higher amylolytic activity in the flour. It also affected the temperature of starch gelatinization.

Gassing power (CO_2 production) as measured in the SJA fermentograph is presented in Table II.

All soy products used increased the volume of CO_2 produced, as compared to the control dough. CO_2 production had increased after 90 min fermentation. After 135 min, the period used in direct method of dough fermentation, textrol had little effect upon CO_2 production, whereas after 225 min fermentation, the time used in

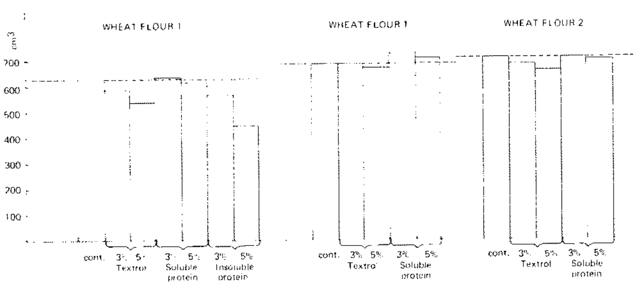

FIG. 1. Effects of method of dough preparation and different doses of textrol and its fractions on the volume of loaf. Direct method, dough yield 100%. Sponge dough method, dough yield 160%.

TABLE II

Effect of Soy Products on CO_2 Production

Fermentation (min)	Control	CO_2 in cc: Textrol 3%	Textrol 5%	Promine F 3%	Promine F 5%	Promine R 3%	Promine R 5%	Promosoy 100 3%	Promosoy 100 5%	Soyalose 103 3%	Soyalose 103 5%
45	160	155	175	160	250	195	185	190	210	150	205
90	510	540	550	550	675	640	605	620	660	610	625
135	925	980	1080	1110	1270	1160	1195	1240	1205	1135	1195
180	1570	1750	1680	1795	2020	2020	1970	1800	1900	1935	1900
225	2300	2920	2460	2575	2660	2595	2615	2505	2565	2550	2620

TABLE III

Effect of Soy Products on Physical Properties of Dough

Characteristic	Control	Textrol 3%	Textrol 5%	Promine F 3%	Promine F 5%	Promine R 3%	Promine R 5%	Promosoy 100 3%	Promosoy 100 5%	Soyalose 103 3%	Soyalose 103 5%
					Wheat flour type 800–good quality						
Water absorption, percent	55.0	59.2	62.2	60.6	63.8	59.0	61.3	60.2	63.2	59.6	61.2
Development and stability, min	5.2	6.2	7.0	5.5	4.5	5.8	4.3	5.9	6.2	5.1	4.4
Elasticity, Br.u.	105	110	120	90	90	100	90	95	105	95	80
Softening, Br.u.	70	65	70	70	80	65	85	60	55	80	80
					Wheat flour type 800–low quality						
Water absorption, percent	52.5	54.4	55.8	57.6	60.6	56.6	58.8	57.0	60.2	56.0	58.0
Development and stability, min	3.8	5.0	5.5	4.3	4.2	4.8	5.1	4.6	5.0	4.5	4.3
Elasticity, Br.u.	110	115	115	120	115	100	100	110	130	110	107
Softening, Br.u.	175	130	110	130	150	150	130	160	155	155	130

sponge dough method, it produced ca. 25% more CO_2 than the control sample.

The accessibility of textrol carbohydrates to bakers yeast as investigated in Einhorn tubes showed little CO_2 production, only 0.2 cc of CO_2 being produced after 5 hr fermentation of 2% textrol solution. It seems that the positive effect of soy products on CO_2 production was caused by the increase of accessible protein which affected the activity of yeast.

The effect of soy products on water absorption and physical properties of wheat dough, as measured by the farinograph is shown in Table III.

The most obvious effect was upon water absorption, which increased ca. 3.8 and 4.7%, respectively, for the two flour samples at the 3% soy level and ca. 6.1 and 7.3%, respectively, with 5% soy added. Time of dough development and dough stability were extended and the degree of dough softening reduced.

To obtain more detailed information concerning the effects of soy products upon the physical properties of dough and upon the volume of the loaf, additional investigations of textrol were made. Textrol was separated into a water soluble fraction, 57.3% protein, and a water insoluble fraction, 75.9% protein. Effects of these fractions on water absorption, physical properties of dough, and bread quality, are presented in Table IV.

The water insoluble fraction increased water absorption of the dough, while the soluble fraction had no effect. Both textrol and its fractions increased dough development and stability in proportion to the amount added. Marked positive effect may be seen on the softening of the dough. The insoluble fraction of textrol was especially effective in reducing dough softening.

These results show that further modifications of soy products are possible and that their action on dough may be modified to meet requirements.

The physical properties of dough containing different levels of soy products as measured by means of the extensograph during the fermentation process showed some drop of dough resistance to extensibility (decrease of proportional number D) and increase of expansion capacity. From the extensograph data the conclusion may be drawn that the "soy dough" became soft and less elastic during the fermentation and may not have been able to

TABLE IV

Effect of Textrol and Its Fractions on Physical Properties of Dough

	Water absorption, %	Development and stability, min	Elasticity Br.u.	Softening Br.u.
Wheat flour type 650	52.8	7.8	160	90
Textrol				
1.5%	54.2	7.8	160	80
3.0%	56.2	9.8	160	70
5.0%	58.4	13.2	160	50
Soluble protein				
1.5%	53.3	9.9	160	80
3.0%	53.5	10.6	150	50
5.0%	53.9	12.0	160	30
Insoluble protein				
1.5%	54.3	10.4	160	60
3.0%	57.0	12.7	140	30
5.0%	59.4	14.2	140	20

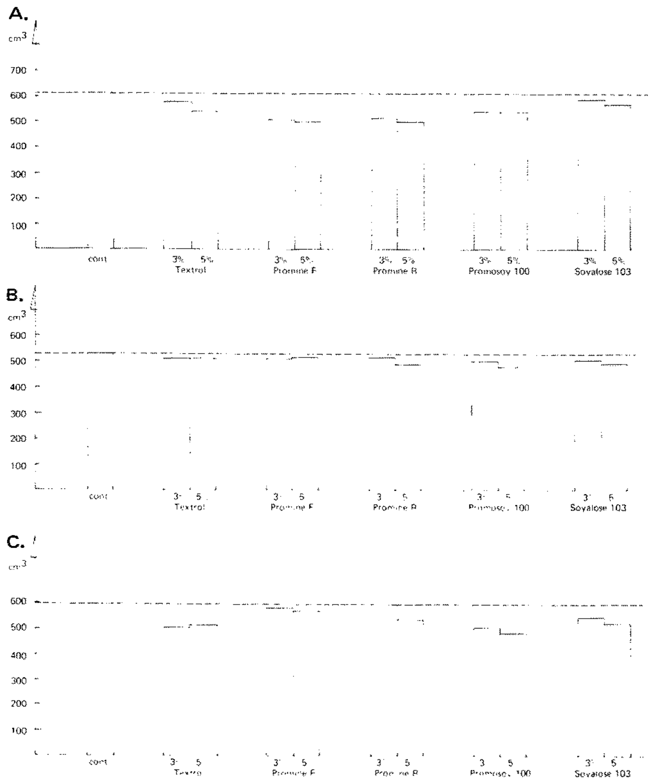

FIG. 2. Effect of the modification of the direct method of dough preparation with different soy products on the loaf volume. A. According to water absorption–fixed proof time. B. According to water absorption–various proof times. C. According to dough yield 160%–various proof times.

hold the CO_2 produced. From these results, it may be seen that use of the farinograph (Table III) as the only index of soy dough quality as is often the case, may lead to erroneous conclusions.

Based upon the results of these investigations, test bakings with different modifications of basic methods were carried out. In Figure 1 the effects of the method of dough preparation and different levels of textrol and its fractions on the loaf volume are presented. Fermentation time of the dough containing 3-5% water soluble fraction textrol had to be ca. 15% less than that of the control sample, and the volume of the loaf was greater than the control no matter which method of dough preparation was used. Both crumb and crust quality were excellent with either flour used which was of good and medium baking qualities, respectively. The water insoluble fraction of textrol produced bread of rather poor quality and small volume.

The inclusion of soy products together with shortenings, emulsifiers, NFDM, and vital gluten made loaves larger in volume than the controls. With the additives, the direct method of dough preparation gave better results, whereas in the case of the poor formula the sponge dough method and addition of soy products to the dough phase gave better results. As a rule the flour of poor baking qualities responded better to the supplementation of soy products and produced better bread than the good quality flour. This phenomenon is of great practical importance for countries where weak wheat flours are used. In this case textrol or any other soy product of similar composition may act as a natural improver and enriching agent at the same time.

The effect of other soy products upon the loaf volume of wheat bread is presented in Figure 2 where the effects of different methods of dough preparation are shown. The method of dough preparation most suitable for the different soy products can be identified. All the soy preparations increased the yield of dough and bread; promosoy 100 and promine F were the most effective. The fermentation period was reduced to ca. 70% of that of the control sample. This result also is of great economical and practical importance.

Application of soy products in the production of rye and mixed wheat and rye bread also gave promising results. Addition of soy products in the last phase of dough preparation, i.e. to the dough, gave rye and mixed bread a satisfactory loaf volume. The quality of crumb, which is the most important factor in the case of rye bread, was very good. In view of the low protein content in rye, this is a promising observation.

The organoleptic analysis of breads containing soy products showed that textrol produced bread had better acceptability than the control. Other soy preparations produced bread similar in acceptability to the control. In case of promosoy 100, the wheat bread was somewhat more sour. This characteristic was not recognized in rye or mixed rye-wheat bread.

OBSERVATIONS

From the results presented above the following observations may be drawn. Addition of textrol to wheat flour changed the quality of wet gluten that was extracted. The more textrol added, the less elastic and more firm wet gluten became. All soy products investigated increased the viscosity of water suspensions of wheat and rye flours. All soy products used increased CO_2 production during fermentation of the dough. Soy products increased water absorption of the dough and improved other rheological properties indicated by farinograph measurements. These positive effects, however, were not confirmed in test baking.

Furthermore, the evaluation of the soy dough during the fermentation process, as measured by the extensograph, showed marked decrease in physical properties, which are associated with a decrease in bread volume. Enrichment of bread with ca. 3% soy products requires some changes in technology, i.e.: (A) extension of dough mixing (ca. 30%); (B) shortening of dough fermentation (ca. 30-50%); (C) in the sponge dough process, soy products should be added to the dough; and (D) in the rye and mixed rye-wheat bread process, soy products should be added to the dough. Of the soy products used, textrol soy flour was most suitable as an enriching protein component.

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