Functional properties of full-fat soy flour from soybeans grown in Ghana. 2. Dough forming ability with wheat flour

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SUMMARY

Farinograph tests used to determine certain parameters in wheat flour dough containing varying amounts of full-fat soy flour samples revealed that most dough forming properties are adversely affected by high levels of full-fat soy flour in the dough. However, at levels between 5 per cent and 10 per cent, the heat-treated samples only increased the water absorption capacity but did not change the other parameters significantly. Raw (enzyme-active) soy flour samples used in comparison with the heat-treated samples were found to pose dough handling problems above 10 per cent and exhibited high mixing tolerance at lower levels. At levels below 10 per cent, both enzyme-active and heat-treated soy flour in wheat flour were found to be suitable in improving the general rheological properties of bread dough. This, in addition to the nutritional advantages in soybean utilization, makes it recommendable for the incorporation of full-fat soy flour in bakery products in developing countries.

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RÉSUMÉ

PLAHAR, W.A. & BEDIAKO-AMOA, B.: *Propriétés, lors de son utilisation, de la farine non dégraissée du soja cultivé au Ghana. 2. Possibilité de mélange avec la farine de blé pour former une pâte à pain utilisable.* Des essais à l'extensimètre ont été faits pour déterminer certains paramètres de la pâte de farine de blé contenant différentes proportions de farine non dégraissée de soja. Il a été observé que la plupart des qualités indispensables pour former une bonne pâte ont été affectées négativement par des adjonctions importantes de farine de soja. Cependant, avec des proportions de soja situées entre 5 et 10 % de farine traitée par la chaleur, la pâte obtenue n'a pas eu ses paramètres modifiés sauf sa capacité d'absorption de l'eau qui s'est accrue. La farine brute de soja (offrant des enzymes actives), par comparaison avec celle ayant subi un traitement par la chaleur, a créé plus de problèmes pour la manipulation de la pâte quand elle a été utilisée en proportion supérieure à 10% mais s'est mélangée au blé avec un haut degré de tolérance à des taux inférieurs. A des proportions inférieures à 10%, la farine brute de soja (à enzymes actives) ou celle traitée par la chaleur, ont été également utilisables en mélange avec la farine de blé et ont amélioré les propriétés générales de viscosité de la pâte à pain; cet avantage s'ajoute à l'augmentation de la valeur nutritive du produit. Il est donc recommandable d'incorporer de la farine non dégraissée de soja en boulangerie, dans les pays en développement.

Introduction

In order to improve the nutritional status of the people in lower economic circles, there is the need to add proteins, minerals and vitamins to commonly used low-cost foods. Wheat flour products are consumed in various forms in most developing countries, but the low content of lysine in wheat proteins has rendered their products nutritionally inadequate to support normal growth and development. In this regard, Light & Frey (1943) demonstrated that the supplementary value of other proteins for wheat protein results from addition of the deficient amino acids, mainly lysine.

Owing to its high lysine content (Ofelt, Smith & Derges, 1954), the soy flour will serve as a very good complement to the essential amino acid content of the wheat flour. Addition of soy flour will, therefore, not only increase the protein content of the wheat flour quantitatively but also improve the protein quality. It also imparts such functional properties as increased mixing tolerance, easier machining, improved moisture retention, and longer shelf-life of baked goods (Mori, Ruwayama & Ishii, 1972).

However, Liener (1958) reported that when added in excess level, the soy flour may cause a deterioration in bread volume, crumb character and dough handing properties. The present investigation aims at finding the behaviour of a full-fat soy flour, as could be prepared by villagers, in wheat flour dough. The effect of both the raw (enzyme-active) and heat-treated samples was examined.

Materials and methods

Preparation of soy flour samples

Two different samples of full-fat soy flour were prepared from the "Hill" variety of soybeans supplied by the Crop Science Department of the Faculty of Agriculture, University of Ghana, Legon, Ghana. A raw (enzyme-active) sample was prepared by dehulling selected soybeans and grinding the dehulled meats to a particle size of about 120 microns in a hammer mill. A second sample (heat-treated) was prepared by first immersion-cooking for 10 min, soybeans soaked in cloth bags for 7 h in tap water. The cooked beans were then sun-dried, dehulled and ground in a hammer mill. This method of soy-flour production is so easy to follow and involves such a cheap technology that it could quite conveniently be applied at the village level.

Determination of dough forming properties

The effects of 5, 10, 15 and 20 per cent levels of both raw and heat-treated soy flour samples on wheat flour dough properties were examined using the large mixing bowl and the constant-flour-weight procedure (A.A.C.C., 1962). Exactly 300 g flour on 14 per cent moisture basis was used. The only modification of the method was that water adsorption was kept constant and dough consistency levels varied.

Basically the farinograph method measures and records the resistance of a dough to mixing. The recorded chart obtained after mixing was interpreted in terms of six parameters. The definitions for these parameters, as given by Mori, Ruwayama & Ishii (1972) are as follows:

Development time. The interval in minutes from start of the curve to the maximum consistency of the farinograph curve.

Departure time. The time in minutes from the start to the point where the top of the curve leaves the maximum consistency line.

Stability. The time difference in minutes between arrival time and departure time.

Arrival time. The time in minutes from the point where the top of the curve first intersects the maximum consistency line.

Tolerance Index. The drop in Brabender Units (BU) from the top of the curve at the peak to the top of the curve measured at 5 minutes after peak is reached.

These properties help to determine the quality of the dough.

Results and discussion

The parameters obtained from the farinogram and taken as the dough properties are shown in Tables 1 and 2. The results show that the replacement of wheat flour with the full-fat soy flour results in higher water absorption and elongates arrival time.

Mori, Ruwayama & Ishii (1972) found in an earlier work that soybean products increase water absorption and elongate both the development time and arrival time in most cases when added to wheat flour. In this study, however, a steady reduction in development time was observed with increase in the raw full-fat soy flour content of the blend while blends with low level heat-treated full fat soy flour were found to reduce the development time slightly but quite considerably at high levels (such as 20 per cent).

Another disparity in the behaviour of the raw and heat-treated soy flour samples was observed

TABLE 1

Readings from Farinograms using Raw Full-Fat Soy Flour

Level of soy flour (per cent)	*Water added (cm³)*	*Maximum consistency (BU)*	*Arrival time (min)*	*Departure time (min)*	*Dough stability (min)*	*Development time (min)*	*Tolerance Index at 5 min (BU)*
0	181.0	500.0	2.0	16.0	14.0	11.0	60.0
5	181.0	500.0	2.25	30.0	27.75	10.5	10.0
10	181.0	540.0	3.0	16.5	13.25	10.25	50.0
15	181.0	560.0	3.25	14.5	11.25	9.0	60.0
20	181.0	610.0	5.25	12.0	7.25	8.0	80.0

TABLE 2

Readings from Farinograms using Heat-Treated Full-Fat Soy Flour

Level of soy flour (per cent)	*Water added (cm³)*	*Maximum consistency (BU)*	*Arrival time (min)*	*Departure time (min)*	*Dough stability (min)*	*Development time (min)*	*Tolerance Index at 5 min (BU)*
0	181.0	500.0	2.0	16.0	14.0	11.0	60.0
5	181.0	540.0	2.0	15.5	14.5	9.0	20.0
10	181.0	670.0	1.5	16.5	15.0	10.0	30.0
15	181.0	620.0	2.0	18.5	16.5	10.5	50.0
20	181.0	630.0	5.0	22.0	17.0	16.0	50.0

in the dough stability. A slight but constant increase in dough stability was recorded with the heat-treated soy/wheat flour blends but the raw (enzyme-active) samples were found to reduce the dough stability at levels above 5 per cent. This finding, therefore, suggests some limits to the conclusion drawn by Pollock & Geddes (1960) that the raw soy flour samples are more tolerable to the farinograph mixing than the heated soy flour. In their experiment, defatted soy flour samples at levels below 5 per cent were used.

In general, at levels of heat-treated full-fat soy flour up to 10 per cent most of the dough properties do not deviate much from those of pure wheat flour. Increase in the maximum consistency on addition of full-fat soy flour shows an increase in the water absorption properties of soy/wheat flour blends. This is desirable since high water absorption usually tends to increase unit yield of the final product.

With the raw soy flour samples it was observed that blends containing over 10 per cent levels formed very sticky dough, making the dough handling very difficult. At 10 per cent level, the dough was only slightly sticky while the effect was hardly noticeable at 5 per cent level of the raw full-fat soy flour in the dough.

Ofelt, Smith & Mills (1955) reported that alpha amylase is one of the enzymes in unheated soy flour that affect dough characteristics adversely.

At low levels, therefore, the raw full-fat soy flour poses the problem of excessive strengthening of the dough while high levels also introduced difficulty in dough handling. The only advantage lies in the relatively low processing cost.

The use of the heat-treated full-fat soy flour at levels 5-10 per cent is, therefore, recommended in breadmaking to impart the nutritional advantages without affecting the dough properties.

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