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Technological and nutritional aspects in hyperproteic bread prepared with the addition of sunflower meal

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Baking and nutritional properties were investigated on mixtures of wheat flour and defatted sunflower meal. Loaves prepared with different mixtures (from 5 to 20% sunflower) were evaluated for volume, weight and external score. The addition of sunflower meal enhanced protein content but had a detrimental effect on bread quality. Incorporation of 10% sunflower meal was found to be acceptable. The addition of maltose to dough improved bread appearance. However, incorporation of sunflower meal produced a bread with a remarkable content of trypsin inhibitors compared with the control. Consequently, proteins are less susceptible to proteolysis. This lower availability of proteins partially nullifies the improvement of the nutritional quality related to the incorporation of sunflower meal. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

The addition of meal from different sources (cereals, soybean, potato, etc.) in bread making to improve wheat flour performance has long been customary.

Sunflower seeds are known to be an excellent source of vegetable proteins, and their nutritional value and functional properties have been extensively studied (Rahma & Narasinga Rao, 1979; Kabirillah & Wills, 1982; Venktesh & Prakash, 1993*a*). Sunflower meal is characterized by high levels of some essential amino acids and is free from toxic compounds (Lusas, 1985; Hoernicke *et al.*, 1988); unfortunately, however, its very poor technological properties, high fibre content and the presence of chlorogenic acid do not allow sunflower seeds to be used extensively in food manufacturing. The dehulling of seeds before milling and the removal of the chlorogenic acid by appropriate procedures (Vaintraub & Krach, 1989; Theertha Prasad, 1990*a,b*) make the sunflower meal suitable for different utilizations (Della Gatta *et al.*, 1984; Rossi, 1988).

The use of defatted meal as well as sunflower concentrates and isolates in bread making has been investigated by some authors (Matthews *et al.*, 1970; Fleming & Sosulski, 1977; Yue *et al.*, 1991). Attention in these studies, is only given to the technological properties of wheat–sunflower mixtures and to the characteristics of the loaves. The purpose of this research work was to evaluate the bread obtained with such mixtures qualitatively and nutritionally. Attention was mainly focused on the digestibility of the high-protein content obtained by incorporating sunflower meal.

MATERIALS AND METHODS

Dehulled sunflower seeds (*Helianthus annuus* L.) were ground with a Cyclotec 1093 (Tecator) mill. The ground meal was treated with hexane (1:10, w/v) for 24 h in a Soxhlet extractor to obtain defatted meal. Chlorogenic acid-free meal was prepared by treating defatted meal, three times, with 70% ethyl alcohol (1:10, w/v) at 40 °C for 30 min; the solvent was removed by air-drying. A commercial wheat flour (type 00) was used for bread making.

Bread was prepared with 100 g of blends (wheat flour plus 5–20% sunflower meal), 3 g of fresh barm, 1.5 g of NaCl and 55 ml of water. The dough obtained was left to leaven at 40 °C for 30 min. Thereafter it was kneaded again and left to ferment for 30 min. The dough was then poured into aluminium dishes greased with butter and baked in an oven at 240 °C for 30 min. Loaf weights and volumes were measured 20 min after removal from the oven. The volume was determined by

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Table 1. Bread quality evaluation for wheat and wheat/sunflower mixtures

Bread composition	Protein (%)	Volume (cm³)	Weight (g)	Spec. vol. (cm³/g)	Score
100% wheat	11.6	330	122	2.7	9
Sunflower percentage					
5%	13.6	330	124	2.7	9
10%	15.4	270	122	2.2	7
15%	18.3	230	126	1.8	6
20%	19.8	200	130	1.5	5
100% sunflower	55.4	—	—	—	—

Scores based on a scale of 1 = poor, 10 = best; loaves evaluated vs wheat flour control.

Table 2. Quality evaluation of maltose-containing bread

Bread composition	Volume (cm³)	Weight (g)	Spec. vol. (cm³/g)	Score
100% wheat	360	130	2.8	10
Sunflower percentage				
10%	310	128	2.4	8

Scores based on a scale of 1 = poor, 10 = best; loaves evaluated vs wheat flour control.

sand displacement. Bread appearance (colour, grain and texture) were scored in comparison with a control loaf (100% wheat flour). Dry bread was ground, as described for seeds, prior to protein and inhibitor determination.

Protein content of flours, mixtures and bread were measured with Kjeldhal's procedure (AOAC, 1970). The factors used for calculating protein content were: 5.7 for wheat; 6.25 for sunflower; or a weighted average of these factors for mixtures. Trypsin inhibitor content was determined on chlorogenic acid-free samples according to Della Gatta *et al.* (1988). For the assay, benzoyl-DL-arginine-p-nitroanilide hydrochloride (BAPA) and salt-free bovine trypsin purchased from Sigma (St Louis, Missouri, USA) were used.

RESULTS AND DISCUSSION

As shown in Table 1, the addition of defatted sunflower meal (from 5 to 20%) to wheat flour produced a marked increase of protein content compared with the control. The highest sunflower incorporation produced an increase in protein content of about 70%. Unfortunately, however, bread quality was poorer as the amount of added sunflower meal increased (Table 1). Loaves were progressively smaller in volume and showed a coarse, dense and compact grain (Fig. 1). This agreed with previous papers in which the incorporation of both sunflower meal and protein isolate were considered (Matthews *et al.*, 1970; Yue *et al.*, 1991). On the basis of extensigraphic studies, the reduction of loaf volume has been attributed by Yue *et al.* (1991) to the non-gluten-forming properties of sunflower meal. Hence, incorporation of such meal is responsible for a dilution of the gluten; for this reason, the doughs appeared to be more resistant to extension.

Increasing sunflower meal percentages were also found to result in increased loaf weight and, of course, a lower specific volume. This could be explained by the greater water-binding capacity of sunflower proteins (Yue *et al.*, 1991). In fact, when the bread was dried, the highest loss of weight (about 25%) was recorded in loaves prepared with 20% sunflower meal. The weight reduction obtained with the lowest sunflower incorporation was 10%, and about 6% in the control.

By comparing the quality parameters relative to the four tested mixtures, we were able to establish that the degree of loaf deterioration is acceptable when sunflower incorporation is less than 10%. The characteristics of bread prepared with this mixture can be improved by adding maltose (2%) to the dough (Table 2). Loaves obtained in this way showed an appreciably

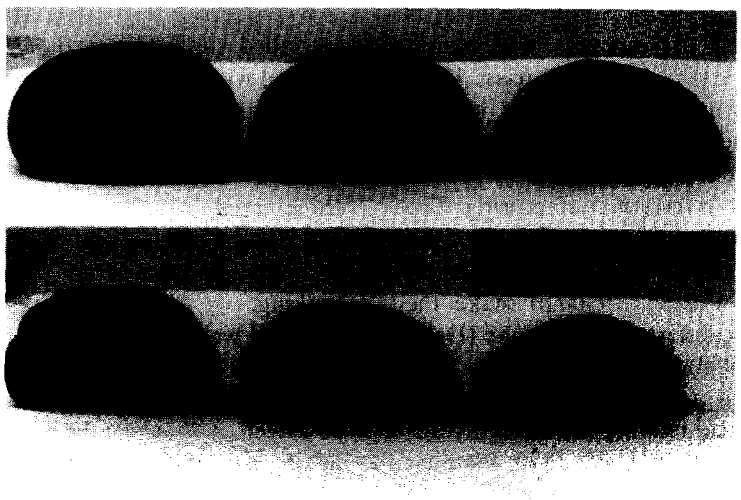

Fig. 1. Effect of sunflower meal addition on loaf characteristics from left to right: control; 10 and 20% of sunflower meal incorporation.

Fig. 2. Effect of maltose addition on load characteristics from left to right: control and 10% of sunflower meal; control and 10% of sunflower meal with maltose addition.

Table 3. Trypsin inhibitor contents in mixtures and in bread

	Mixtures (TIU/g subst.)	Bread (TIU/g subst.)	Reduction (%)
100% wheat	283	< 5	98
100% sunflower	530	—	—
Sunflower percentage			
5%	296	82	72
10%	310	112	64
15%	320	132	59
20%	335	140	58

(TIU = Trypsin inhibitor units).

better appearance coupled with increased volume (about 15%) and a slightly increased weight (Fig. 2). Improvements of loaf volume or quality were not obtained to any extent by Yue *et al.* (1991) by adding potassium bromate, an oxidizing agent, to wheat blends with both concentrate and isolate sunflower proteins.

The use of mixtures containing 10% sunflower meal is acceptable, not only from a technological point of view, but also because they allowed a considerable increase of bread protein content to be obtained (about 33%). Of course, this increase will be effective, if the proteins are really available for digestion. The resistance of heated sunflower proteins to proteolysis has recently been described by Venktesh & Prakash (1993*b*). They attribute this resistance to several factors among which they suggest presence of protease inhibitors.

It is well established that the extent of proteolysis is reduced by the presence of trypsin inhibitors (TI) in foods (Rackis *et al.*, 1986). Consequently, evaluation of such anti-nutritional compounds allows protein availability to be evaluated. Data on the measurement of TI in both meals and mixtures utilized in this study are summarized in Table 3. As shown, wheat had an appreciably lower TI activity than that of sunflower (about 50%). However, if TI contents are expressed vs proteins, an inverted trend can be observed as 2.4×10^3 TIU g^{-1} protein and 0.96×10^3 TIU g^{-1} protein are the activities for wheat and sunflower, respectively.

The TI content found in bread was constantly lower than in the corresponding mixtures (Table 3). Reduction ranged from 58 to 72% as the amount of sunflower meal incorporation decreased. No activity was found in the control loaf. Although these results confirm the efficacy of cooking to reduce the anti-nutrients present in foods, the remaining TI activity detected in loaves was appreciably higher than in the control. This could be explained by a different nature of the TI present in the mixtures: heat-labile, e.g. those of wheat (these disappeared completely after cooking as was confirmed by the control loaf), and mainly heat-resistant, e.g. those of the sunflower meal (the activity increased with the percentage of incorporated sunflower meal).

CONCLUSIONS

Although more investigations are needed to clarify the characteristics of sunflower TI, the data discussed above confirm the resistance of sunflower meal proteins to hydrolysis by proteolytic enzymes recently described (Venktesh & Prakash, 1993*b*). A consequence of the TI activity observed in loaves is a partial reduction of the improvement obtained by incorporating sunflower meal in bread making. This suggests that high-protein vegetable meals cannot be used in food production without evaluating the activity of the digestive enzyme inhibitors in the products. Only the possibility of obtaining foods with higher nutrient contents, without incorporating anti-metabolites or toxic compounds in meals, can be regarded as an actual improvement of quality.

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