2011 International Nuclear Atlantic Conference - INAC 2011
Belo Horizonte,MG, Brazil, October 24-28, 2011
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
***ISBN:* 978-85-99141-04-5**

TECHNOLOGICAL CHARACTERISTICS OF BREADS CONTAINING INTEGRAL IRRADIATED FLOURS

Christian A. H. M. Teixeira[1], Nelida L. del Mastro[1]

1 Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
nlmastro@ipen.br

ABSTRACT

Wheat is normally used to make bread, pasta, and noodles, because among the cereal flours, only wheat flour has the ability to form cohesive dough upon hydration. For that reason, only partial substitution of wheat flour can be recommended. In this work, pan breads were prepared with 30% content of irradiated whole wheat, whole rye and coarse cornmeal and the influence of blending on bread making capabilities investigated through some technological characteristics. All-brand wheat, rye and cornmeal flours were irradiated with 0, 1, 3 and 9 kGy in a ^{60}Co and the deformation force, height and weight of breads prepared with those blends were then determined. Breads prepared with irradiated whole wheat flour showed an increase in the deformation force with the increase of radiation dose. The bread height presented also an increase for the doses of 1 and 3 kGy. Breads prepared with refined wheat flour blended with irradiated whole rye flour showed an increased deformation force for radiation doses of 1 and 3 kGy and an increase in weight for samples irradiated with 1kGy. Coarse cornmeal blended flour showed a great increase of the deformation force upon irradiation, and an increase in weight for samples irradiated with 3 kGy. The results indicate that the addition of irradiated integral flour, whole wheat, whole rye flour and cornmeal to wheat flour may confer changes in physical properties beside an increment in nutritional value.

1. INTRODUCTION

Breadmaking is a complex process mainly consisting of mixing, fermentation, and baking, in which water evaporation, volume expansion, starch gelatinization, protein denaturation, and crust formation occurs [1]. Wheat is normally used to make bread, pasta, and noodles, because among the cereal flours, only wheat flour has the ability to form cohesive dough upon hydration [2]. Wheat dough entraps gas, which is essential for the production of light and leavened products such as bread and pastry). These properties are mainly attributed to the gluten proteins that generate a continuous viscoelastic network during dough development. Protein constitutes only 7% to 15% of common wheat flour including albumins and globulins, and gluten accounts for 80% to 90% of flour proteins [3].

Although both the flour from the whole grains and the flour that has been refined can be used for bread, the former is nutritionally preferable to the latter because it is rich in dietary fiber (DF). The Codex Alimentarius [4] defines DF as carbohydrate polymers with 10 or more monomeric units, which are not hydrolyzed by the endogenous enzymes in the small intestine of humans. In addition to associated health benefits, incorporation of DF to food products can impart a number of functional properties to the finished foods, including increased water holding, gel forming, stabilizing, texurizing, and thickening capacities according to Gelroth & Ranhotra [5].

Corn, barley, cassava, sweet potato, arrowroot, bananas, soybeans and sunflower seeds, for example, were used as partial substitutes of wheat flour and shown to increase the nutritional value of breads, reducing imported wheat demand [6]. According to studies by Bhattacharjee et. al. [7], the partial substitution of wheat by other grains did not generate changes in production and sensory characteristics of breads.

The treatment of food by ionizing radiation is accepted for specific purposes in many countries, among them Brazil. Ionizing radiation can induce changes in the properties of food products through phenomena of polymerization, depolymerization or cross-linking of the macromolecular components. As cross-links among wheat proteins and fiber polysaccharides could occur as a result of irradiation, the present work aimed at studying some technological characteristics of breads prepared with blends of refined wheat and some irradiated whole grain flours.

2. EXPERIMENTAL

2.1 Material

Samples of refined wheat, whole wheat, whole rye and cornmeal flours, within the validity period of six months, obtained locally, were used.

2.2 Irradiation

Samples of wheat, whole wheat, whole rye and cornmeal were irradiated in a ^{60}Co source, Gammacell 220 from Atomic Energy of Canada Ltd. at doses of 0, 1, 3 and 9 kGy, dose rate about 1.6 kGy/h.

2.3 Bread making

Breads prepared with the addition of whole wheat, whole rye or cornmeal were made with the following formulation: wheat flour (42%), integral flours (18%), water (24%), milk (6%), salt (1%), sugar (2%), yeast (2%) butter (6%). For the pan breads confection, the following sequence was employed: mixture of the ingredients for eight minutes at 90 r m^{-1}; a first fermentation for 40 minutes at 25^o C; division of the dough in portions of 500 g; ten minutes of resting time at 25^o C; cylindrical shaping of the dough and place them on rectangular pans (12cm x 30cm x 10cm); final fermentation for one hour and twenty minutes at 25^o C; baking at 160^{o}C in an air convection oven; cooling period of 45 minutes. Measurement of height (at the center of each bread) and weight were then performed.

2.4 Texture analysis

The maximum deformation force was determined using a Extralab model TAXT2i Analyzer following the procedure recommended by the manufacturer, using two slices of bread, about four centimeters height and an aluminum cylindrical probe of 36mm diameter.

2.5 Statistical Analysis

A SigmaStat Version 1.0 for Windows 1994 from Jandel Corporation was employed. One way ANOVA was used to determine if the data fit a normal distribution. As it was no the

case, a nonparametric Kruskal-Wallis test was employed to determine the median and the first and third quartiles and the variation significance among the samples.

3. RESULTS AND DISCUSSION

Measurement of the changes in weight, height, and maximum deformation force of breads prepared with different kinds of integral flours, irradiated in different doses was made.
Table 1 showed the results of the blend containing refined wheat flour with 30% integral wheat flour. In this case, there was an increase in the deformation force with the increase of radiation dose and a slight decrease of weight of bread prepared with it. The bread height presented also a significant increase but only for the breads prepared with flour irradiated with doses of 1 and 3 kGy.

Table 1. Variables of pan breads made of wheat flour with 30% integral wheat flour substitution irradiated at different doses

Dose (kGy)	Deformation Force (N)	Height (cm)	Weight (g)
0	2.2 [2.2; 2.4]^{d}	9.0 [9.0; 10.0]^{b}	448 [448; 450]^{a}
1	2.5 [2.5; 2.6]^{b}	11.5 [10.5; 12.5]^{a}	446 [445; 446]^{b}
3	3.4 [3.4; 3.9]^{c}	11.0 [11.0; 12.0] ^{a}	446 [446; 447]^{b}
9	4.0 [3.8; 4.1]^{a}	9.5 [9.0; 10.0]^{b}	444 [443; 445]^{c}

Medians and quartiles (25% ; 75%). Values in the same column with different superscripts differ significantly ($P < 0.05$).

The increase in height of breads can be ascribed to the greater amount of fermentable sugars in the flour resulting from the breakdown of starch by irradiation [8] that is used as a substrate for the action of yeast [9].

Breads prepared with refined wheat flour blended with 30% irradiated whole rye flour showed an increased deformation force for radiation doses of 1 and 3 kGy and an increase in weight for samples irradiated with 1kGy as presented in Table 2.

Table 2. Variables of pan breads made of wheat flour with 30% whole rye flour substitution irradiated at different doses

Dose (kGy)	Deformation Force (N)	Height (cm)	Weight (g)
0	2.0 [1.9; 2.1][c]	10.5 [10.4; 10.5][a]	441 [439; 443][b]
1	3.0 [2.8; 3.2][a]	8.2 [8.0; 8.4][d]	446 [444; 448][a]
3	2.5 [2.3; 2.8][b]	8.5 [8.4; 8.6] [c]	440 [438; 443][b]
9	1.6 [1.5; 1.6][d]	9.0 [8.8; 9.1][b]	433 [432; 434][c]

Medians and quartiles (25% ; 75%). Values in the same column with different superscripts differ significantly ($P < 0.05$).

In Table 3 are displayed the results obtained for breads prepared with a blend of refined wheat and 30% of coarse cornmeal. In this case, the bread showed a great increase of the deformation force upon irradiation, and an increase in weight for samples irradiated with 3 kGy.

Table 3. Variables of pan breads made of wheat flour with 30% cornmeal substitution irradiated with different doses

Dose (kGy)	Deformation Force (N)	Height (cm)	Weight (g)
0	1.6 [1.5; 1.7][c]	9.0 [8.9; 9.0][a]	441 [440; 443][b]
1	6.3 [5.5; 6.9][a]	8.0 [8.0; 8.2][b]	438 [437; 441][c]
3	6.0 [5.8; 6.6][a]	7.0 [6.9; 7.2][c]	446 [446; 448][a]
9	2.4 [2.4; 3.6][b]	8.0 [7.8; 8.0][b]	441 [439; 442][b]

Medians and quartiles (25% ; 75%). Values in the same column with different superscripts differ significantly ($P < 0.05$).

Teixeira et al. (*unpublished results*) [10] studied the effects of ionizing radiation on refined wheat flour and found an increase in the enzymatic activity and depending of the irradiation dose, an increase in texture, weight and height on the bread based on this flour. In the present work, the wheat flour was partially substituted by irradiated all-brand cereals. In all the cases the deformation forces increased when the added irradiated integral flours were irradiated with 1 and 3 kGy.

4. CONCLUSION

Present results showed that ionizing radiation at the doses of 1, 3 and 9 kGy applied to whole-grain flours generated modifications in the characteristics of the breads prepared with it. Although the irradiation process is generally applied to preserve the hygienic quality of products, irradiation of different kinds of flours, may have some beneficial technological characteristics for use in bread production.

ACKNOLEDGEMENTS

The authors gratefully thank Eng. Elizabeth S.R. Somessari and Eng. Carlos Gaia da Silveira for guidance in the irradiation operation. Financial support from CNPq is also acknowledged.

REFERENCES

1. Sivam, A.S., Sun-Waterhouse, D,. Quek, S.Y., Perera, C.O., Properties of Bread Dough with Added Fiber Polysaccharides and Phenolic Antioxidants: A Review, *Journal of Food Science,* **75**, pp. R163-R174 2010.
2. L´etang C, Piau M, Verdier C., Characterization of wheat flour-water doughs. Part I: rheometry and microstructure, *Journal of Food Engineering*, **41,** pp. 121–132 1999.
3. Shewry PR, Halford NG, Belton PS, Tatham AS., The structure and properties of gluten: an elastic protein from wheat grain, *Philos Trans R Soc*, **357**, pp. 133–142 2002.
4. ALINORM 09/32/26. 2009. *Report of the 30th session of the Codex committee on nutrition and foods for special dietary uses* 3–7. Appendix II. 46 p. Cape Town, South Africa.
5. Gelroth J, Ranhotra GS, *Handbook of dietary fibre,* Cho SS, Dreher ML, editors, New York, USA 2001.
6. Batista, K.A.; Prudêncio, S.H.; Fernandez, K.F., Wheat Bread Enrichment with Hard-to-Cook Bean Extruded Flours: Nutritional and Acceptance Evaluation, *Journal of Food Science*, **76**, pp. S108-S113 2011.
7. Bhattacharjee, M.; Othira, J. O.; Wanjama, J. K.; Maina, J. O., Effects of selected composite wheat flours on bread baking quality, *Discovery and Innovation*, **18**, pp. 98-103 2006.
8. Chung, H. J., Liu, Q., Effect of Gamma Irradiation on Molecular Structure and Physicochemical Properties of Corn Starch, *Journal of food Science*, **74**, pp. C353-C361 2009.
9. Calvel, R., *The french bread and correlated products,* Editora J. Macêdo S.A., Fortaleza, Brasil 1987.
10. Teixeira, C.H.M., Inamura, P.Y., Uehara, V.B., Mastro, N.L.d, Gamma radiation influence on technological characteristic of wheat flour, *Radiat Phys Chem. (submitted to publication).*