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A sensory evaluation of irradiated cookies made from flaxseed meal

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ABSTRACT

The growing consumer demand for food with sensory quality and nutritional has called for research to develop new products with consumer acceptance as cookies made from flaxseed meal, that can be inserted in diet of celiacs. Celiac disease characterized by an inappropriate immune response to dietary proteins found in wheat, rye and barley (gluten and gliadin). It can affect anyone at any age and is more common in women. The celiac disease does not have cure and the only scientifically proven treatment is a gluten free diet. Irradiation as a decontamination method used for a many variety of foodstuffs, being very feasible, useful method to increase the shelf life, effective and environmental friendly without any sensory properties significant change. Sensory analyses were used to assess gluten-free bakery foods subjected to ionizing radiation sensory attributes.

1. Introduction

Celiac disease is characterized by permanent intolerance to gluten found in wheat, rye, barley, malt, oats and in some other cereals. Nevertheless, celiacs cannot consume foods that contain this protein otherwise many symptoms can be developed such as weakness, loss of weight, and diarrhea due to bad absorption of nutrients in the small intestine (Ciclitira et al., 2005). The treatment for celiac disease is a gluten-free diet (Ciclitira and Moodie, 2003). The preparation of gluten-free bakery products requires application of different flours in exchange for wheat flour using gluten-free products, which would improve their expansion, structure and taste of foods (Gallagher et al., 2004), to contribute with the people with celiac disease to fulfill the nutritional directions (Thompson, 2000; Case, 2005).

Flaxseed is one of those healthy ingredients that is easy to sneak into foods as cookies, increasing the nutritional value. Flaxseed proteins have been assessed as techno-functional ingredients in many food formulations such as bakery products and pastries, meat emulsions, sauces and ice creams. Functional properties of flaxseed proteins including emulsifying and foaming ability and stability are comparable to those of other oilseed proteins. The advantage of flaxseed proteins compared to other vegetable proteins arises from their association with the mucilage, a co-product in flaxseed, which may enhance their properties in food formulation (Rabetafika et al., 2011).

Flaxseed has been identified as a functional food, whose benefits to health are generally attributed to high concentrations of lignins and linolenic acids (omega-3) lignins. (Conforti and Davis, 2006; Oomah et al. 2006). The accordance with Hussain et al. (2006) the linolenic acid has beneficial effect on reducing the risk of cardiovascular disease on the growth and development of children, stroke, inflammatory and immunological disorders. Phytoestrogens, such as lignans, act on the estrogen metabolism and are purported to serve as an adjuvant in hormone replacement therapy and breast and prostate cancer prevention strategies (Knust et al., 2006). Flaxseed contains approximately 28% fiber that can reduce cholesterol, regulate blood glucose, preventing constipation and providing protection against colon cancer (Hussain et al., 2006).

The gamma irradiation improve the safety, efficiency, is suitable for disinfestation, microorganism load reduction or sterilization, increase the shelf life of food (Sommers, 2004). Food irradiation has been approved by several authorities (FDA, USDA, WHO, FAO, etc.) and scientific societies based on extensive research (Tritsch, 2000; Morehouse, 2002). Ionizing radiations do not cause any significant rise in temperature and the flavor, texture or other important technological or sensory properties of most ingredients are not influenced at low radiation doses (Farkas, 2006).

Sensory analysis is the examination of a food through the evaluation of the attributes sensorial of product that were subjected to irradiation processes. The analysis is applied in the improvement of the quality and development of foods, besides to show the acceptance of the consumer to the product (Carpenter et al., 2000; Schröder, 2003). The objective of this work was

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formulate gluten-free cookies to verify the effect of low dose of gamma radiation in sensory properties of all samples.

2. Material and Methods

2.1. Gluten-free cookie

The cookies were prepared by the continuous mixture of the raw materials, previously weighed in analytical scale, rolling and pressing the dough with a metallic cylinder in a way that all the cookies presented the same thickness until it reached 3.0 cm diameter. The cookies were then baked for 25 min at monitored temperature of 180 ± 2 °C. After that, they were cooled in room temperature (23 °C) and conditioned in packed up in polyethylene until analyses. The concentration values of the ingredients per 100 g of final cookies are in Table 1.

The cookies were baked, cooled, packaged and after 15 h the products were irradiated.

2.2. Irradiation

The samples were irradiated at Nuclear and Energy Research Institute—IPEN/CNEN (São Paulo, Brazil) using a Gammacell 220 cobalt-60 (MDS Nordion Ottawa, Canada Ltd). The applied doses were 0, 0.5 kGy, 1.0 kGy and 1.5 kGy. The applied dose rate was 1.67 kGy/h. The percentual of maximum dose and minimum dose receive at each of these 3 doses were 15%. Harwell Amber 3042 dosimeters were used to measure the radiation dose.

2.3. Sensorial test of acceptance

The tests were carried out the Dietetic Techniques Laboratory, College of Public Health of University of São Paulo.

The test was carried out with 30 panelists. Samples were inside a digit codified plastic container and were given to the panelists with a cream cracker savory biscuit and one glass of water (45 mL), so the palate could be cleaned Tests took place in individual cabins illuminated by fluorescent lamps. Test of acceptance the panelists evaluated each sample according a 9 point hedonic scale (1=dislike extremely and 9=like extremely); a score of 5 was considered the limit of acceptance (Stone and Sidel, 1993).

The project was approved by the Ethics Committee of the College of Public Health of University of São Paulo (research protocol number: 2253).

2.4. Measurement of water activity (Aw)

The measurement of water activity of the cookies at 20.7 °C was conducted after the samples were irradiated using an Aw analyzer (Aqua Lab Model Series 3TE, Decagon Devices, Inc., Pullman, WA, USA) previously calibrated with a lithium chloride solution. The measurements were carried out three times.

Table 1
Concentration values of the ingredients of final cookies ingredients.

Ingredients	Concentration values (% (w/w))
Flaxseed meal	21
Sugar	35
Eggs	25
Hydrogenated vegetable fat	17
Yeast powder	0.9
Sodium chloride	0.7
Vanilla essence	0.4

2.5. Statistical analysis

Statistical analysis were performed by ANOVA, with a $p < 0.05$, in order to evaluate significant differences among irradiation doses analyzed.

3. Results and discussion

The sensorial acceptance test showed no significant difference between control and irradiated (0.5 kGy, 1.0 kGy, 1.5 kGy) samples. This test was carried out to evaluate a possible sensorial change observed by the consumers, in relation to the different radiation dose response. The results (Table 2) of difference appearance demonstrated no significant difference between control and irradiated samples in a level significance 95%.

Villavicencio et al. (2007) analyzed that a dose of 2.0 kGy is sufficient to maintain the sensorial quality to chocolate and banana and 3.0 kGy to strawberry in cereal bars. Food-radiation processing was utilized as a safe and effective solution. The product can be free of insect contamination, prolong storage life and sensorial test approved for the ionizing treatment with the doses applied.

Hozová et al. (1997) analyzed the evaluation of microbiological, nutritional and sensory quality and of the water activity values of amaranth-based biscuits produced from the amaranth grain irradiated by various ionizing radiation doses (1.5 kGy, 3.0 kGy and 5.0 kGy, source Co-60) and stored for the period of 12 months at the temperature (20 ± 2 °C and $RH = 62 \pm 1\%$). The irradiation dose providing the biscuits maximum nutritional, hygienic and sensory quality maintained up to the end of the one-year storage was 5.0 kGy.

The measurement of water activity is important considering the development of a product, can be used for the determination of shelf-life and it is an analysis of quality control (Pham, 2001). The water activity is useful tool of the baking process (Cheftel and Cheftel, 1977).

Ameur et al. (2007) quantified water activity ranging from 0.336 ± 0.019 to 0.452 ± 0.031 in cookies and Mundt and Wedzicha (2007) analyzed biscuits and found Aw no higher than

Table 2
Averages of difference test appearance.

Doses (kGy)	Averages of difference test appearance
Control	7.7 [a]
0.5	7.2 [a]
1.0	7.0 [a]
1.5	7.1 [a]

[a] Averages followed by the same latter do not have a significative difference by Tukey test ($p < 0{,}05$).

Table 3
Measurement of water activity of cookie samples gluten-free cookies irradiated and non irradiated.

Doses (kGy)	Water activity
Control	0.385[a]
0.5	0.373[a]
1.0	0.381[a]
1.5	0.372[a]

The letter "a" represent different statistical results do not have a significative difference by Tukey test ($p < 0{,}05$).

0.40. In this study were obtained (Table 3) that the cookie samples gluten-free cookies irradiated and non irradiated can be considered microbiological safe because under $Aw = 0.400$ there is no free water that can be used for microbial growth (Pham, 2001).

4. Conclusion

Therefore, the sensorial analysis of gluten-free cookie did not have significant difference in the acceptance test between irradiated and control samples. Irradiation did not have a significant negative impact on the appearance, odor and taste, according to statistical analyses. Sensorial test approved for the ionizing treatment with the doses applied. Important options to substitute bakery goods for celiac patients.

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References

Ameur, L.A., et al., 2007. Comparison of the effects of sucrose and hexose on furfural formation and browning in cookies baked at different temperatures. Food Chem. 101 (4), 1407–1416.
Carpenter, R.P., Lyon, D.H., Hasdell, T.A., 2000. Guidelines for sensory analysis in food product development and quality control, second ed. Aspen.
Case, S., 2005. The gluten-free diet: how to provide effective education and resources. Gastroenterology 128, 128–134.
Cheftel, J.C., Cheftel, H., 1977. Introduction à la biochimie et à la technologie des aliments. Lavoisier, Paris 420.
Ciclitira, P.J., Johnson, M.W., Dewar, D.H., Ellis, H.J., 2005. The pathogenesis of celiac disease. Mol. Aspects Med. 26, 421–458.
Ciclitira, P.J., Moodie, S.J., 2003. Coeliac disease. Best Pract. Res. Clin. Gastroenterol. 17 (2), 181–195.
Conforti, F.D., Davis, S.F., 2006. The effect of soya flour end flaxseed as a partial replacement for bread flour in yeast bread. Int. J. Food Sci. Technol. 41 (2), 95–101.
Farkas, J., 2006. Irradiation for better foods. Trends in Food Sci. Technol. 18, 1–5.
Gallagher, E., Gormley, T.R., Arendt, E.K., 2004. Recent advances in the formulation of gluten-free cerealbased products. Trends Food Sci. Technol. 15, 143–152.
Hozová, B., Buchtová, V., Dodok, L., Zemanovic, J., 1997. Microbiological, nutritional and sensory aspects of stored amaranth biscuits and amaranth crackers. Nahrung 1 (3), 155–158.
Hussain, S., Anjum, F.M., Butt, M.S., Khan, M.I., Asgharl, A., 2006. Physical and sensoric attributes of flaxseed flour supplemented cookies. Turk. J. Biol. 30, 87–92.
Knust, U., Spiegelhalder, B., Strowitzki, T., Owen, R.W., 2006. Contribution of linseed to urine and serum enterolignan levels in German females: a randomised controlled intervention trial. Food and Chem. Toxicol. 44, 1057–1064.
Morehouse, K.M., 2002. Food Irradiation—US regulatory considerations. Radiat. Phys. Chem. 63, 281–284.
Mundt, S., Wedzicha, S.M., 2007. A kinetic model for browning in the baking of biscuits: effects of water activity and temperature. LWT—Food Sci. Technol. 40 (6), 1078–1082.
Oomah, B.D., Der, T.J., Godfrey, D.V., 2006. Thermal characteristics of flaxseed (Linum usitatissimum) proteins. Food Chem. 98, 733–741.
Pham, Q.T., 2001. Modelling thermal process: cooling and freezing. In: Tijskens, L.M.M., Hertog, M.L.A.T.A., Nicolai, B.M. (Eds.), Food process modeling. Woodhead Publishing Limited, Cambridge, pp. 312–339.
Rabetafika, H.N., Remoortel, V.V., Danthine, S., Paquot, M., Blecker, C., 2011. Flaxseed proteins: food uses and health benefits. Int. J. Food Sci. Technol. 46, 221–228.
Schröder, M.J., 2003. Food Quality and Consumer Value. Springer-Verlag, Berlin 330.
Sommers, C., 2004. Food irradiation is already here. Food Technol. 58 (11), 22.
Stone, H.S., Sidel, J.L., 1993. Sensory Evaluation Practies, 2ed. Academic Press, San Diego 338.
Thompson, L., 2000. Folate, iron and dietary fibre contents of the gluten-free diet. J. Am. Diet. Assoc. 1000, 1389–1396.
Tritsch, G.L., 2000. Food irradiation. Nutrition 16 (7–8), 698–718.
Villavicencio, A.L.C.H., Araujo, M.M., Fanaro, G.B., Rela, P.R., Mancini-Filho, J., 2007. Sensorial analysis evaluation in cereal bars preserved by ionizing radiation processing. Radiat. Phys. Chem. 76, 1875–1877.