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Influence of storage time for the acceptability of bread formulated with lupine protein isolate and added brea gum

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ABSTRACT

The purpose of the research was to study the influence of storage time on the acceptability of bread made with lupine protein isolate and brea gum. Three bread formulations were studied: bread with wheat flour: lupine protein isolate (90:10) and brea gum, bread with wheat flour: lupine protein isolate (90:10) without brea gum, and a control bread (100% wheat flour). Texture Profile Analysis variables, moisture, dehydration rate, colour and acceptability were measure at fresh, 24, 48 and 72 h of storage. The crumbs made with flour mixture had more moisture at all storage times, and the addition of brea gum further increased this difference. After 24, 48 and 72 h of storage, the bread crumbs with lupine protein isolate (with and without brea gum) had a lower hardness ($^*P < 0.05$). In general, the addition of brea gum made breads more cohesive, gummy, springy and chewy ($^*P < 0.05$). All the crumbs tended to be less bright. At 48 h brea gum improved the acceptability ($^*P < 0.05$) and this was accentuated at 72 h of storage, where 80% of consumers had a positive acceptance because of the "*good crumb flavour*". The addition of this hydrocolloid increased the sensory shelf-life of the product.

1. Introduction

Lupine (*Lupinus mutabillis sweet*) is a leguminous plant, which has been used as food by people of the Andean highlands (Doxastakis, Zafiriadis, Irakli, & Tananahi, 2002). Lupine protein has a high nutritive value and the main interest relates to its high content of lysine (El-Adawy, Rahama, El-Bedawy, & Gafar, 2001).

Hydrocolloids are widely used to bake products for retarding staling and/or for improving the quality of fresh products (Hager & Aredent, 2013; Polaki, Xasapis, Fasseas, Yanniotis, & Mandala, 2010).

The brea gum (BG) is a hydrocolloid obtained as phloematic exudate of *Cercidium praecox,* specie of semi-arid regions of Argentina. The gum is collected manually by native people from superficial incisions made in the branches and trunks. BG is highly soluble in water (28.3% at 25 °C), and the solutions present acid character (pH = 4). This hydrocolloid contains residues of L-arabinose, D-xylose, D-glucuronic acid and 4-O-methyl-D-glucuronic acid (Cerezo, Stacey, & Webber, 1969), associated with small amounts of protein. BG has similar composition and structure to the arabic gum (De Pinto, Rodriguez, Martinez, & Rivas, 1993). Hence, BG could be a suitable candidate for incorporation as stabilizing, emulsifying and thickening additive.

Bread is essential in people's diet and one primary source of energy, as it is rich in carbohydrates, but is poor in quantity and quality of proteins (Bowles & Demiate, 2006). Moreover, it is a product characterized by a short shelf-life, resulting in the rapid onset of signs of staling, mainly related to the increase of the hardness of the crumb (Curti, Carini, Tribuzio, & Vittadini, 2014),

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which then affects its acceptability (Hough, Langohr, Gomez, & Curia, 2003). For these reasons, this paper aims at improving the quality of the protein in bread by incorporating lupine protein isolate, which has peculiar lysine content, and extends the lifetime of the product through the addition of a native hydrocolloid from Argentina.

Moreover, this study aims at sharing significant findings with the scientific community and the food industry. In addition, this investigation intends to contribute with the use of BG, which has recently been incorporated into the Argentine Food Code.

Finally, the objective of this research was to study the influence of storage time on the acceptability of bread, made with lupine protein isolate and BG.

2. Material and methods

2.1. Raw materials

Lupinus mutabillis Sweet seeds from Bolivia were used. Native BG was provided by indigenous communities from Chaco Salteño (Argentina). Commercial wheat flour (WF) (moisture: 10 g/100 g; protein: 11.8 g/100 g; ash: 0.71 g/100 g), compressed yeast, and other ingredients were purchased from local markets.

2.2. Lupine protein isolate (LI): obtaining, chemical composition and colour profile

Lupine seeds were crushed, using a household mill (Braun, Germany), and then defatted by soaking in petroleum ether (Cicarelli, analytical grade) for 20 h with four solvent changes. The defatted flour was air-dried at 25 °C and grounded to pass through a 0.173-mm ASTM sieve (80-mesh); it was used for preparing the protein isolate by alkaline water extraction/isoelectric precipitation, following the method proposed by El-Adawy et al. (2001).

Crude fat, protein, moisture and ash contents of LI were determined according to the AACC (2000) methods 30–10, 46–30, 44–15 and 08–01 respectively. Protein content was calculated with a 6.25 conversion factor. The carbohydrates were calculated by difference. Each analysis was performed for triplicate.

2.3. Purified brea gum

Grinding, dissolution, decantation, filtration and drying in an oven (at 30 °C), were the steps followed in the purification process. Since the BG has high solubility in water, the powder was solubilized in the water required for kneading to ensure a good distribution of the hydrocolloid throughout the dough (López, Pérez, Jiménez, & Cuevas, 2013).

2.4. Baking test and storage conditions

Table 1 shows the composition of the samples. Control bread was also elaborated.

Ingredients were mixed (10 min), kneaded and rolled in the commercial bread maker machine (ATMA easy cook). The dough was fermented (27°C-95 min), kneaded (25 min), and it was baked at 150 °C for 60 min. Finally, the breads were cooled to room temperature (120 min). For the study of ageing, the loaves were placed unpacked into a special camera and stored at 25 °C ± 2 °C with a 75–80% relative humidity for 24, 48 and 72 h. Three pieces of each type of bread were prepared and stored.

2.5. Physical parameters and chemical composition

Each loaf was characterized by, volume (V) (rapeseed displacement), specific volume (SV) (Dall'Asta et al., 2013), Specific volume index (SVI) (López et al., 2013) and Width/height ratio of the central slice (W/H) (Curic et al., 2008).

The analysis of the crumb structure was performed using the method and software proposed by Sciarini, Ribotta, León, and Pérez (2012). Calculations include: total area cells (%) (TAC), average size of the cells (mm) (ASC), and number of cells per unit area (n °C/cm^2). Three replicates for each sample were carried out.

Moisture, ash, crude fat and proteins, following the AOAC (1995) methods 925.09, 923.03, 922.06, 991.20 respectively, were analysed. The carbohydrate content was calculated by difference. Protein content was calculated using a 5.7 conversion factor. Three replicates for each sample were carried out.

2.6. Crumb staling evaluation

The breads staling was determined by the variation in the moisture (AOAC, 1995, method 925.09), dehydration rate (Davidou, Le Meste, Debever, & Bekaert, 1996), TPA parameters and colour, at different storage times.

The TPA was performed using a QTS 25 Texturometer (Brookfield, USA). A 2.5 cm thick slice was compressed with a 38.1 mm acrylic probe up to 40% deformation, at 120 mm/min speed and a relaxation period of 10 s between de first and second compression. An instrumental trigger of 5 g was applied. The hardness (g), cohesiveness, gumminess (g), springiness (mm) and chewiness were obtained. On average, six measurements per bread were made.

The colour of crumb was determined according to the CIELAB parameters (L^*, a^*, b^*) using a ColorTec, PCM colorimeter (Accuracy Microsensor Inc., Pittsford, USA), equipped with light source of D65 and an observation angle of 10°.

2.7. Overall acceptability and sensory shelf-life

Overall acceptability was measured in a total of 12 samples: WF, WF:LI, and WF:LI + BG at the four storage times. Regular consumers of bread, (203: 128 female, 75 male, aged between 18 and 40 years) evaluated the acceptability in a 9-point structured hedonic scale (9 = I like very much, and 1 = I dislike very much). Moreover, the following question was made: "*Would you consume this bread?*"

Table 1
Breads formulations (ingredients are expressed as percentage on a 100 flour/blend basis).

Bread	Ingredients				
	Wheat flour	Lupine protein isolate	Dried yeast	Salt	Brea gum
WF:LI	90	10	1.6	2	0
WF:LI + BG	90	10	1.6	2	0.5
WF	100	0	1.6	2	0

WF: wheat flour bread; WF:LI: wheat flour: lupine protein isolate bread; WF:LI + BG: wheat flour: lupine protein isolate with brea gum bread. The amount of water was calculated according to farinograph water absorption (data not shown).