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EFFECT OF THE EXTRUSION PRECOOKING AND CHICKPEA FLOUR ADDITION ON GLUTEN-FREE AND VEGAN BREADS

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ABSTRACT:
Nowadays, there is a growing market for gluten-free baked goods for vegans. Usually, thedough viscoelasticity to make gluten-free breads is achieved with ingredients derived from animal origin (egg and milk). The objective of this study was to evaluate the effect of chickpea flour addition ($\boldsymbol{X_1}$: 10%, 20%, and 30%) and the use of flours' blend based on white rice ($\boldsymbol{X_2}$: raw and precooked by extrusion) in the preparation of breads free of gluten, egg and milk ingredients. Breads made with raw flour had a higher specific volume, regardless of chickpea flour addition. Hardness and gumminess were higher in breads produced with raw flour and 20% $\boldsymbol{X_1}$. On the other hand, breads made with precooked flour and 10% $\boldsymbol{X_1}$ were more cohesive. The differences found in the treatments could be attributed to the combined action of the proteic fraction subjected to various degrees of modification during the extrusion cooking process. The bread made with raw flour and 20% $\boldsymbol{X_1}$ presented the most uniform crumb.

Keywords: gluten-free bread, extrusion cooking, bakery product, vegan product.

INTRODUCTION

The demand for gluten-free breads without the use of egg and milk as main ingredients, is growing because more and more vegans and lactose intolerant people, as well as people who do not have any celiac disease pathology but wish to follow a plant-based diet. Most gluten-free products on the market have unsatisfactory nutritional and technological quality because gluten is responsible for the dough, providing flexibility and gas retention capacity. In addition, gluten-free breads usually have low nutritional values, as they are usually made with refined or non-refined cereals with low protein value (Bernardes *et al.*, 2022).

With the addition of legume flours such as chickpea flour and the use of precooked flours by extrusion at intermediate moisture, breads with acceptable characteristics can be produced. Extrusion cooking of cereal-legume mixtures thermoplasticizes starch granules and thermosets proteins. Chickpea has a high protein content and has emulsifying properties, foaming capacity and high oil absorption capacity, which makes it an ingredient suitable for baking (Santos *et al*., 2021).

The objective of this study was to evaluate the addition of chickpea flour and the use of raw flour/precooked flour by extrusion (flours blend of white rice/chickpea), in the preparation of gluten-free and vegan breads.

MATERIALS AND METHODS

Flour preparation. White rice grains and chickpea grains were acquired from commercial trades at local markets in Rio de Janeiro, Brazil. Both grains were size reduced up to particles ≤0.250 mm (for raw flours) and ≤1 mm (for precooked flours) using a combination of laboratory millers (discs, rollers, and hammers). The resultant flours were blended according to a factorial design 3×2.

Extrusion cooking process. Each flours blend of white rice/chickpea were moistened at 24% (wet basis) and manually homogenized. Then, they were cooked in a single-screw extruder (Brabender 19/20 DN, coupled with a 3:1 compression ratio screw and a 3 mm frontal die. The temperature profile was fixed at: 40, 90, and 120°C, the screw speed at 150 rpm, and the feed rate of solids at 4 kg/h using a volumetric feeder (Brabender, 625415,394).

Formulation and bread making procedure. Both, raw and extruded flours were incorporated to a base formulation containing instant yeast, refined sugar, table salt, olive oil, potato starch, cassava starch, xanthan gum, carboxy-methyl cellulose, and water. The dough was manually worked, then separated in portions of 150 g, molded and placed into previously greased steel molds of 150 cm^3 capacity, and rested for 60 min in a fermentation cabinet conditioned at 30°C and 85% RH. The dough was baked in a convective oven at 150°C for 120 min. Then, the breads were cooled and stored for 24 h in a dissicator.

Specific volume analysis. The bread volume was measured according to the 10-05.01 method (AACC, 2000) using standardized diameter millet seeds. The container used to measure the bread apparent volume was a cylinder of plastic material (11 cm diameter, 7 cm height). The specific volume (SV, cm^3/g) was calculated as the inverse of the bread apparent density.

Texture profile analysis (TPA). It was carried out with a Texture Analyser TA-XT Plus (Stable Micro Systems, Surrey, UK) equipped with a 5 kg load cell. An aluminum probe of cylindrical base (15 mm diameter) was coupled to the texturometer, which deformed the crumb area of bread slices of 25 mm thickness by up to 50%. Then, the following texture parameters were calculated from the force-distance curve: hardness (Ha), cohesiveness (Co), and gumminess (Gu).

Experimental design and statistical Analysis. The treatments were arranged either in a 3×2 (for SV) or in a 2×2 (for TPA) factorial experiments, with two replicates. The independent variables were X_1: chickpea flour addition (10, 20, and 30%), and X_2: flour type incorporated in the dough (raw, and precooked by extrusion). The assessed responses on breads were: specific volume and texture parameters. For each response, factorial ANOVAs following multiple comparison of means by Tukey's test, with α = 0.05, were carried out. Then, response curves were generated.

RESULTS AND DISCUSSION

The assessed responses after performing the analysis of variance and Tukey's test are shown in Figure 1. It was verified that breads produced with raw flour showed the highest specific volume values (Figure 1A), regardless of chickpea flour addition (1.15 cm^3/g vs. 0.9 cm^3/g).

Regarding texture parameters, the hardness of breads produced with raw flour was higher only with 20% chickpea flour addition (55 N vs. 25 N). Bread cohesiveness was higher when precooked flour was used only with 10% chickpea flour addition (0.49 vs. 0.38). With respect to gumminess, it was observed that breads produced with raw flour had greater gumminess only with 20% chickpea flour addition (25 N vs. 12 N).

Figure 1 – Effect of chickpea flour addition and flour type on: A) specific volume,B) Hardness,C) Cohesiveness, and D) Gumminess. Different lowercase letters differ according to the Tukey test.

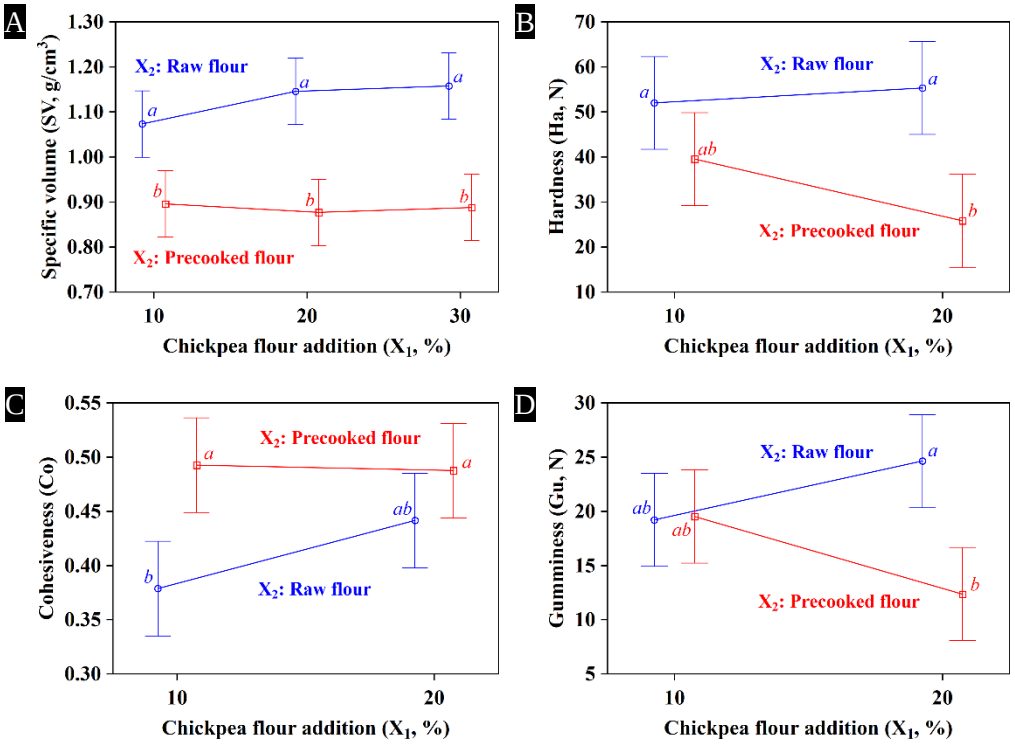
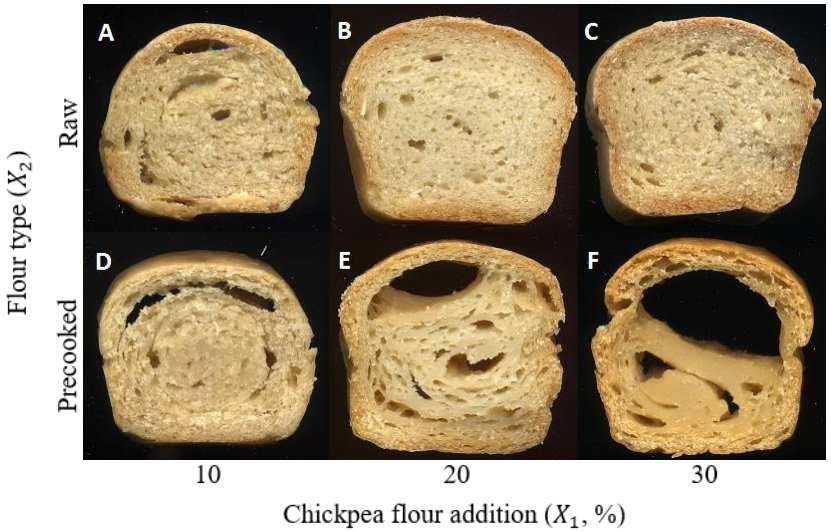


Figure 2 shows the differeces in the breads crumb as a result of chickpea flour addition and the flour type incorporated in the formulation (raw and precooked by extrusion). As the proportion of chickpea flour addition was increased in the precooked flour, a smaller area of the crumb was observed, with the formation of large air bubbles. The bread crumb consistency made with 30% chickpea flour addition and precooked flour (Figure 2F) was more compact than the others. This fact could be associated to a greater water retention by chickpea proteins.

Figure 2 – Visual aspects of bread slices.



CONCLUSION

The flour type incorporated in the bread formulation affected the specific volume. Precooked flours decreased the breads' specific volume. Chickpea flour addition in combination with the flour type used affected the breads' texture parameters. Breads produced with raw flour (non extruded) presented uniform crumbs, being better with 20% chickpea flour addition (Figure 2B). These differences could be linked to the combined action of the chickpea proteic fraction under going diverse degrees of modification during the extrusion cooking process. For future works, it is suggested to blend different proportions of raw flour and precooked flour in order to obtain a gluten-free and vegan bread with acceptable technological properties and nutritional characteristics.

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