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Proceeding Paper

Effect of Hydroxypropyl Methylcellulose, Xanthan Gum, and Psyllium in the Formulation of Gluten-Free Bread for the Improvement of Organoleptic Quality †

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Abstract: Gluten-free bread is a new option for a population unable to digest gliadins and glutenins. This study compared the texture and color of four formulations, each containing varying amounts of hydroxypropyl methylcellulose (HPMC), psyllium, xanthan gum, and water. It was found that removing xanthan gum reduced the hardness and gumminess of the breadcrumbs. Increasing the amount of psyllium increased gumminess and redness. Interestingly, increasing the amount of HPMC in the formulation did not show significant differences. This suggests that HPMC may not have a pronounced effect on texture and color compared to the control formulation.

Keywords: gluten-free; bread; hydroxypropyl methylcellulose (HPMC); psyllium; xanthan gum; texture profile analysis (TPA)

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1. Introduction

Gluten is a glycoprotein found in commonly consumed grains such as wheat, barley, and rye [1]. It is associated with conditions such as celiac disease and altered immune function [2,3]. This fact has led to an increase in gluten-free products in recent years, although their production is one of the most challenging [4]. The gluten network serves not only to trap fermentation gases but also plays a role in creating the crumb's cell structure, resulting in distinct texture and flavor characteristics not found in other baked products [5]. However, developing gluten characteristics in doughs can prove challenging. Currently, the most common ingredients used to aid in this process are hydrocolloids, specifically hydroxypropyl methylcellulose (HPMC), xanthan gum, psyllium husk fiber, and guar gum [6]. This study aimed to compare and evaluate the color and texture of four gluten-free bread formulations, each containing a varying amount of hydroxypropyl methylcellulose (HPMC), psyllium husk fiber, and xanthan gum.

2. Materials and Methods

2.1. Formulations

2.1.1. Ingredients

Gluten-free bread was made with corn starch (Roquette, Benifaió, Spain), rice flour (Arrocerías San Cristóbal, Sollana, Spain), tapioca starch (Vicorquimia, Badalona, Spain), sucrose (Aceites La Canal, Chella, Spain), sunflower oil (Aceites La Canal, Chella, Spain), rice syrup (Ferrer Alimentación, Barcelona, Spain), compressed yeast (Lesaffre Iberica, Valladolid, Spain), and EGM gluten-free bread mix (Sinblat Alimentación Saludable, Foios, Spain), which was made of salt, inactive sourdough, sodium bicarbonate, monocalcic phosphate, pea protein, bamboo fiber, potassium sorbate, calcic propionate, natural flavors, and enzymes.

Gluten replacers were hydroxypropyl methylcellulose (HPMC) Vivapur K4M (Rettenmaier Ibérica, Barcelona, Spain), xanthan gum (Brenntag, Dos Hermanas, Spain), and psyllium husk fiber (Barcelonesa, Cornellà de Llobregat, Spain).

2.1.2. Gluten-Free Breadmaking

A gluten-free bread recipe was composed as follows (per 100 g flour and starch): 91.2 g of maize starch, 5.5 g of rice flour, 3.3 g of tapioca starch, 17.9 g of EGM gluten-free bread mix, 5 g of sucrose, 26.2 g sunflower oil, 7.1 g rice syrup, and 7.7 g of compressed yeast. HPMC, xanthan gum, psyllium, and tap water were added in varying amounts to each formulation. Differences in composition can be observed in Table 1.

Table 1. Composition of the formulations in the study (g/100 g flour and starch).

Ingredient / Formula	Xanthan Gum (g)	HPMC (g)	Psyllium (g)	Water (g)
FC	3.2	3.6	9.8	159.7
F1	3.2	4.4	9.8	164.0
F2	3.2	3.6	13.2	173.6
F3	0	3.6	9.8	148.5

FC: control formula. F1: HPMC increase. F2: psyllium increase. F3: xanthan gum removal.

All the ingredients were mixed using a Sigma Aeromix mixer with a hook tool, all mixed at speed one for 15 min. The dough was divided into pieces weighing 440 g and shaped by hand before being put into a Teflon-coated metal mold measuring 9.9 × 19.1 × 6.8 cm. The molds were fermented in a Bauuman fermenter at 29 °C and 80% relative humidity. After fermentation, the bread pieces were placed in an oven (Loguidice, FOX 10T-LFRC) and baked at 210 °C for 2 min, followed by 38 min at 180 °C. Once baked, the breads were removed from the mold and allowed to cool in a room at 25 °C for 2 h. Afterward, loaves were sliced, packed in polypropylene bags, and stored under controlled conditions (22–25 °C, 50–70% RH). Bread samples were analyzed 48 h after production.

2.2. Analysis

2.2.1. Crumb Color

Crumb color analysis was measured with a colorimeter (CR-400, Konica Minolta, Osaka, Japan). Color was measured in six replicates and these measurements were repeated for each formulation. The device was calibrated using a standard illuminant D65, and a 10° observer. Readings were displayed as a*, b*, and L* color parameters according to the CIELAB system of color measurement. The a* value is a measure of greenness ranging from −100 to +100 (redness), the b* value ranges from −100 (blueness) to +100 (yellowness), while the L* value indicates the measure of lightness and ranges from 0 (black) to 100 (white).

2.2.2. Texture Analysis

Crumb firmness was evaluated using a TA-XT Plus (Stable Micro Systems, Godalming, UK) texturometer. Texture profile analysis (TPA) was performed on 8 slices, 5 mm thick, of each formulation. A P/75 compression platform, 5 mm/s test speed, and 50% deformation were used. Hardness, adhesiveness, cohesiveness, and gumminess were measured.

2.2.3. Statistical Analysis

The data were analyzed using the analysis of variance (ANOVA) technique, with the Fisher LSD test at a 95% confidence level ($p < 0.05$). These statistical analyses were carried out using Statgraphics Centurion XVII v204 8 64 bits.

3. Results and Discussion

3.1. Color

Color is an important characteristic of baked products because it contributes to consumer preference [7]. Table 2 displays the means and standard deviations of the results acquired during the color characterization process. There are no significant differences in the L* parameters; however, in the bibliographic research, it was found that Ziemichód, M et al. [8] indicate a significant reduction in crumb lightness when psyllium is added. Additionally, Sabanis, D et al. [9] observe a decrease in L* values with an increase in HPMC in gluten-free breads. They also indicate that decreasing the amount of xanthan gum can lead to decreases in L* values compared with formulations with higher amounts of xanthan gum. In terms of a*, F2 is significantly superior, which can be seen as an increase in redness due to the increase in psyllium in the formulation [8]. Belorio et al. show in their study that the addition of xanthan gum to a recipe made with rice flour resulted in an increase in redness. Although no significant differences were observed in their corn flour recipe with xanthan gum, this analysis indicated that the lowest value was obtained with F3, which connected the removal of xanthan gum to the reduction of redness in the crumb [9]. Finally, there are no major differences in b*, with the modified formulations tending to be lower than the control. Nevertheless, there are significant differences between F1 and F3, that is, FC and F1 are significantly more yellow than F3 [8].

Table 2. Mean values ± standard deviations of color parameters of the crumbs.

Formula	L*	a*	b*
FC	65 ± 2^{a}	1.1 ± 0.3^{b}	11.5 ± 0.9^{c}
F1	65 ± 2^{a}	1.1 ± 0.3^{b}	11.2 ± 0.8^{bc}
F2	64 ± 3^{a}	1.5 ± 0.4^{c}	11.0 ± 0.9^{ab}
F3	64 ± 3^{a}	0.9 ± 0.4^{a}	10.8 ± 1^{a}

The same letter in superscript within the column indicates homogeneous groups established by ANOVA ($p < 0.05$). FC: control formula. F1: HPMC increase. F2: psyllium increase. F3: xanthan gum removal.

3.2. Textural Characterization

Texture is a crucial factor in the sensory experience of the consumer. Alterations in this parameter can influence the ease and satisfaction of chewing [10]. Table 3 shows the means and standard deviation results of TPA analysis. In this table can be seen a significantly lower hardness in F3, the formula that removed xanthan gum, compared with the other formulations. This reduction in hardness may be due to an increase in the specific volume of the bread, as explained by Lazaridou et al. [11]. In addition, many authors have seen an increase in the volume of bread after adding xanthan gum using different blends, concentrations, and types of flour [12]. Gumminess is defined as the result of the product's hardness and cohesiveness. F2 had the highest value. This fact may be because an increase in psyllium increases hardness when compared with other hydrocolloids such as HPMC [13]. Otherwise, some studies show an increase in crumb cohesiveness caused by psyllium [8,14]; and since gumminess is the product of hardness and cohesiveness, this fact may explain the increase in gumminess of F2. Adhesiveness is defined as the work required to remove a material from a surface, measured in grams per second (g). As demonstrated in Table 3, the breadcrumb of formulation 3 is less adhesive. Some bibliographical studies, such as this one by Enzina-Zelada CR et al., have found an increase in adhesiveness associated with a decrease in xanthan gum [15]. It is worth noting that there are no significant differences in all parameters between FC and F1. Therefore, the increase in HPMC in F1 may not play a significant role in the final texture of the product. Although an increase in HPMC does not increase bread hardness [16], a lower hardness was observed when the hydrocolloid was used in lower concentrations [12,16].

Table 3. Mean ± standard deviation of the texture profile analysis (TPA) of the crumbs in the study.

Formula	Hardness (g)	Adhesiveness (g.s)	Cohesiveness	Gumminess (g)
FC	5994 ± 809 [b]	−4 ± 3 [a]	0.60 ± 0.02 [ab]	3603 ± 495 [b]
F1	6184 ± 1038 [b]	−4 ± 3 [a]	0.59 ± 0.13 [a]	3625 ± 984 [b]
F2	6597 ± 1410 [b]	−5 ± 2 [a]	0.63 ± 0.05 [b]	4153 ± 770 [c]
F3	4720 ± 1180 [a]	−2 ± 2 [b]	0.60 ± 0.04 [ab]	2832 ± 760 [a]

The same letter in superscript within the column indicates homogeneous groups established by ANOVA ($p < 0.05$). FC: control formula. F1: HPMC increase. F2: psyllium increase. F3: xanthan gum removal.

4. Conclusions

Following the study, there are some significant differences between the tested formulations. F1 is the formulation that has an increase in HPMC compared with the control formulation. Nonetheless, since there were no considerable differences, an increase in HPMC is not recommended, as it does not improve the analyzed parameters. The psyllium content is higher in F2 than in the control formula. This rise in hydrocolloids caused an increase in the redness and gumminess of the breadcrumbs. Finally, F3 is the formulation in which xanthan gum was eliminated. This resulted in a breadcrumb with lower levels of hardness and gumminess, as well as a less adhesive breadcrumb. As a result, it can be concluded that F3 is the most advisable due to the texture improvement produced by the removal of the hydrocolloid.

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