DEVELOPMENT AND QUALITY OF RICE FLOUR-BASED GLUTEN-FREE MUFFINS

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INTRODUCTION

The increasing demand for gluten -free products has favoured the design of numerous gluten free bakery products which intended to mimic the quality characteristics of wheat bakery products. Rice is one of the most convenient cereals for designing gluten-free products. However, some food additives such as starches, gums, hydrocolloids, and dairy products are required for obtaining good quality characteristics such as high volume, soft texture, and so on. Xanthan gum is one of the gums frequently included in food formulations to improve the mouth feel and to adjust the rheological properties (Turabi et al., 2008). The aim of this study was to design a sweet formulation for obtaining rice flour muffins based on a traditional Spanish recipe, but formulations were eggs-free and lactose-free. With that purpose, the effect of different levels of xanthan gum as structuring agent on the quality of the product was tested.

MATERIALS AND METHODS

Rice flour-based gluten-free muffins were prepared without xanthan gum (XG) as control and with three different levels of XG (0.3%, 0.5% and 0.7%). The ingredients (g/100g flour) used in the preparation of the muffins batters were based on a traditional Spanish recipe, but formulations were eggs-free and lactose-free: 114.4g rice flour (10.8% moisture, 6.69 % protein); 100g water; 75g sugar; 46g refined sunflower oil; 4g sodium bicarbonate; 3g citric acid; 1.5g salt; 0, 0.3, 0.5 or 0.7g XG. The samples were identified as control, 0.3%XG, 0.5%XG, and 0.7%XG according the content of XG added. The batter and baked muffins were prepared according to methods described by Sanz et al. (2009). Gluten-free muffins characterization was carried out 24 h after baking. The weight loss upon baking was calculated. Height was measured with a digital calliper. Volume was determined by rapeseed displacement. Specific volume was calculated by dividing volume by weight. Water activity (aw) of muffins samples was measured using an Aqua Lab Series 3. A Konica Minolta CM-3500 spectrocolorimeter was used to measure the crumb colour, the parameters measured were *L**, *a**, and *b**. Images of the muffins were captured using a flatbed scanner equipped with the software HP PrecisoScan Pro version 3.1. The instrumental texture measurements of the muffins samples (1.5 cm high lower halves) were made with a TA.XT2 Texture Analyzer (Stable Microsystems, Surrey, UK) provided with Texture expert software. A double compression test was performed up to 50% sample deformation with a 75 mm diameter flat-ended cylindrical probe (P/75), at a speed of 1 mm/s. The parameters obtained from the curves were hardness, springiness, cohesiveness, chewiness, and resilience.

Each formulation was prepared twice (two replicates), on different days, and four muffins from each batch (8 determinations) were measured.

RESULTS AND DISCUSSION

Figure 1 shows the effect of XG incorporation (0.3-0.7%) on rice flour-based gluten-free muffins. The 0.5% XG sample differed from the other gluten-free muffins. The control, 0.3% XG, and 0.7% XG muffins contained larger bubbles than 0.5% XG sample. These large bubbles formed tunnels from the base to the surface. The best crumb structure was observed with 0.5% XG, those muffins showed more homogeneous and less compact structure, with large and small air bubbles, which conferred an aerate appearance.

Control 0.3% XG 0.5% XG 0.7% XG

Figure 1. Photographs of cross sections of the different rice flour-based gluten-free muffins (5.9 cm of diameter). Control gluten-free muffins and gluten-free muffins with different level of xanthan gum (XG).

Table 1 show that the incorporation of XG barely affected height, weight loss, specific volume, and water activity of the gluten-free muffins and no trend was observed with the amount of XG. The values obtained were lower than those reported for similar gluten-free products (Turabi et al., 2008; Gularte et al., 2011), although their formulations was different.

Table 1. Effect of xanthan gum (XG) incorporation on some quality characteristics of rice flour-based gluten-free muffins.

Samples	Height (mm)	Weight loss (g)	Specific volume (cm^3/g)	Water activity
Control	32.64 ± 1.58 ^{a}	7.57 ± 0.28 ^{b}	1.28 ± 0.07 ^{a}	0.90 ± 0.01 ^{a}
0.3% XG	33.37 ± 1.65 ^{ab}	7.17 ± 0.42 ^{a}	1.35 ± 0.04 ^{b}	0.90 ± 0.01 ^{a}
0.5% XG	33.66 ± 2.22 ^{ab}	7.25 ± 0.21 ^{ab}	1.32 ± 0.05 ^{ab}	0.90 ± 0.00 ^{a}
0.7% XG	35.22 ± 0.74 ^{a}	7.20 ± 0.35 ^{ab}	1.33 ± 0.05 ^{ab}	0.90 ± 0.00 ^{a}
P- value	0.1605	0.0755	0.1579	0.4974

Mean values (n=8) followed by the same letter are not significantly different ($p \leq 0.05$).

The increase in XG produced an increase in lightness (Table 2). *L**crumb values ranged from 66.37 (0.3% XG sample) to 72.84 (0.7% XG sample). Regarding *a**, in all formulations was very close to 0, and samples presented positive *b** value, indicating hue on yellow axis.

Table 2. Effect of xanthan gum (XG) incorporation on the crumb colour parameters of rice flour-based gluten-free muffins.

Samples	Crumb colour parameters		
	L*	a*	b*
Control	67.33 ± 1.21 ^{b}	0.37 ± 0.13 ^{c}	17.15 ± 0.77 ^{b}
0.3% XG	66.37 ± 0.54 ^{a}	0.37 ± 0.23 ^{c}	16.95 ± 0.82 ^{b}
0.5% XG	72.07 ± 0.77 ^{c}	-0.40 ± 0.53 ^{a}	18.82 ± 0.58 ^{c}
0.7% XG	72.84 ± 1.74 ^{d}	-0.11 ± 0.39 ^{b}	15.61 ± 0.68 ^{a}
p- value	0.0000	0.0000	0.0000

Mean values (n=8) followed by the same letter are not significantly different ($p \leq 0.05$).

In Figure 2, TPA curves for the different muffins formulation are shown. The TPA parameters obtained from the curves are shown in Table 3. The increase in XG decreased significantly ($p<0.05$) hardness, springiness, cohesiveness, chewiness and resilience in comparison to the control. The highest effect was observed with 0.7% XG. Springiness, cohesiveness, and resilience decreased reflecting denser and more compact crumb. Martínez-Cervera et al. (2011) also found a decrease in hardness in muffins with XG incorporation.

Table 3. Effect of percentage of xanthan gum (XG) on the texture characteristics of rice flour-based gluten-free muffins.

Samples	TPA parameters				
	Hardness (N)	Springiness	Cohesiveness	Chewiness (N)	Resilience
Control	239.30 ± 14.30 ^{c}	0.83 ± 0.01 ^{c}	0.63 ± 0.02 ^{c}	126 ± 6.70 ^{c}	0.31 ± 0.01 ^{c}
0.3% XG	164.92 ± 9.67 ^{b}	0.79 ± 0.02 ^{b}	0.62 ± 0.01 ^{bc}	80.76 ± 6.49 ^{b}	0.29 ± 0.01 ^{b}
0.5% XG	149.22 ± 18.62 ^{ab}	0.76 ± 0.02 ^{a}	0.62 ± 0.01 ^{bc}	70.04 ± 8.42 ^{a}	0.28 ± 0.01 ^{b}
0.7% XG	138.13 ± 19.74 ^{a}	0.76 ± 0.02 ^{a}	0.60 ± 0.01 ^{a}	62.80 ± 9.98 ^{a}	0.26 ± 0.01 ^{a}
p- value	0.0000	0.0000	0.0002	0.000	0.000

Mean values (n=8) followed by the same letter are not significantly different ($p \leq 0.05$).

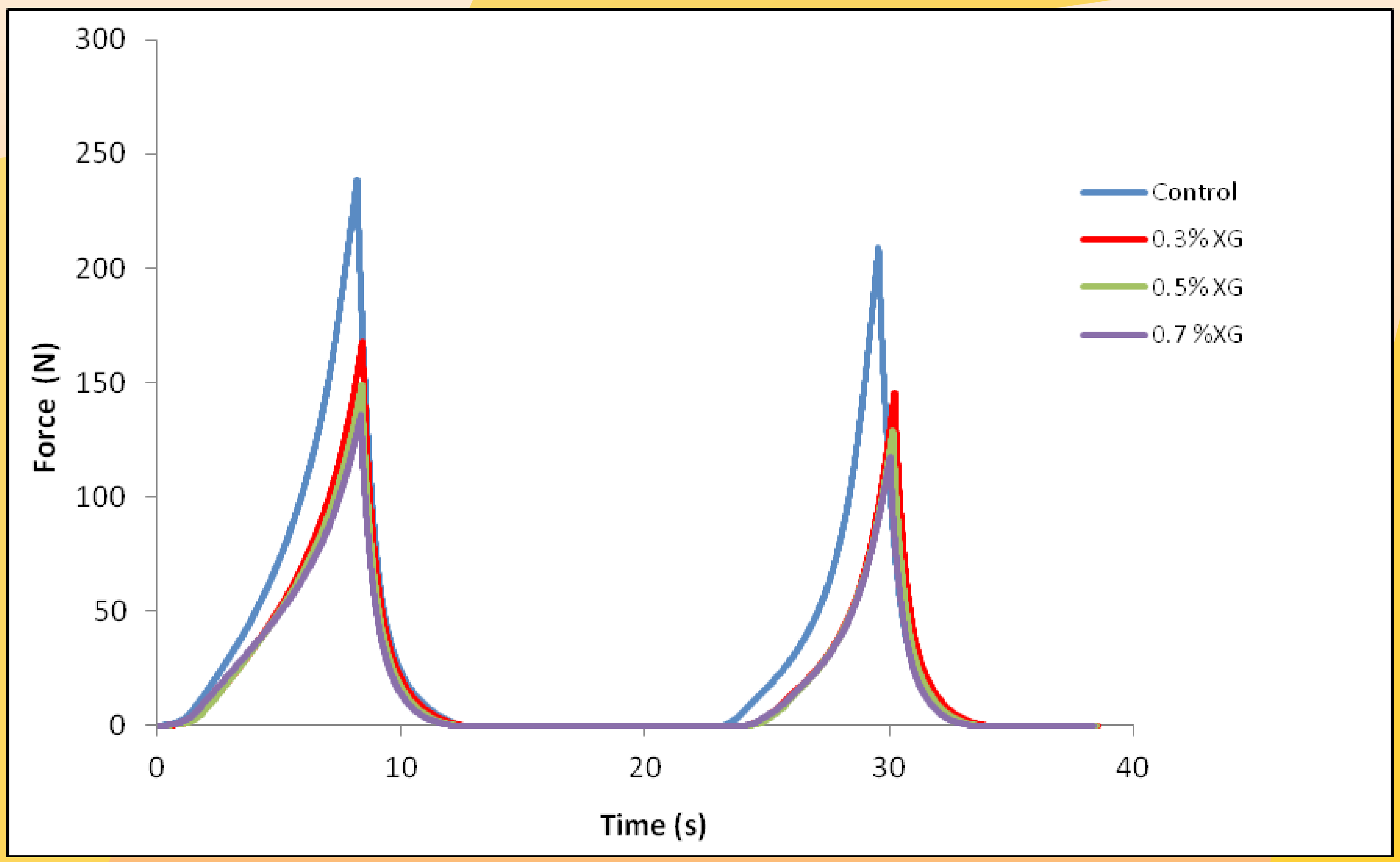

Fig. 2. TPA curves for the different rice flour-based gluten-free muffins. Control gluten-free muffins and gluten-free muffins with different level of xanthan gum (XG).

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CONCLUSIONS

The results obtained in this study showed that it is possible to produce rice flour-based gluten-free muffins for celiac patients using xanthan gum as structuring agent. Xanthan gum improves the texture characteristics of rice-flour based gluten-free muffins. Overall, gluten-free muffins with 0.5% XG showed the best crumb structure, and the best quality characteristics. Nevertheless, it seems that the incorporation of xanthan gum was not enough to improve the volume and texture of this type of gluten-free muffins.