TEXTURAL QUALITY ATTRIBUTES OF GLUTEN-FREE BATTER AND BREAD AS AFFECTED BY HYDROCOLLOIDS

Christian R. Encina-Zelada[1,4,5], Vasco Cadavez[1], Fernando Monteiro[2,3], José A. Teixeira[4], Ursula Gonzales-Barron[1]

[1]CIMO Mountain Research Centre, School of Agriculture, Polytechnic Institute of Braganza, Portugal
[2]Department of Electrical Engineering, School of Technology and Management, IPB, Portugal
[3]INESC-TEC - Institute for Systems and Computer Engineering, Technology and Science, Porto, Portugal
[4]Centre of Biological Engineering, School of Engineering, University of Minho, Portugal
[5]Faculty of Food Industries, National Agricultural University La Molina, Lima, Peru

email: cencina@lamolina.edu.pe

Objectives

(i) to unveil and compare the separate effects of xanthan gum (XG), guar gum (GG) and hydroxyl-propyl-methyl cellulose gum (HPMC) on gluten-free batter and bread quality;
(ii) to explore the interrelationships between physicochemical and texture characteristics of gluten-free batter and bread.

Materials and methods

Gluten-free bread was produced using: rice (50%), corn (30%) and quinoa flour (20%), sunflower oil (6% flour weight), white sugar (3%), refined salt (1.5%) and instant yeast (3%).

- Twenty-seven formulations were produced: 1.5, 2.5, 3.5% **XG** and 90, 100, 110% of water (nine combinations); 2.5, 3.0, 3.5% **GG** and 90, 100, 110% of water (nine combinations); and 3.0, 4.0, 5.0% of **HPMC** and 80, 90, 100% of water (nine combinations).

Breadmaking process:

Bread was prepared according to Fig.1.

Batter analysis

- Stickiness analysis (**STK**)
  - stickiness (g)
  - work of adhesion (g.s)
  - cohesiveness-strength (mm)
- Back extrusion analysis (**BE**)
  - firmness (g)
  - consistency (g.s)
  - cohesiveness (g)
  - viscosity index (g.s)

Physicochemical properties

- Water activity (a_w)
- pH
- specific volume (ml/g)
- baking loss (%)

Texture profile analysis (TPA)

- Hardness (g)
- adhesiveness (g.s)
- springiness (-)
- cohesiveness (-)
- gumminess (g)
- chewiness (g)
- resilience (-)

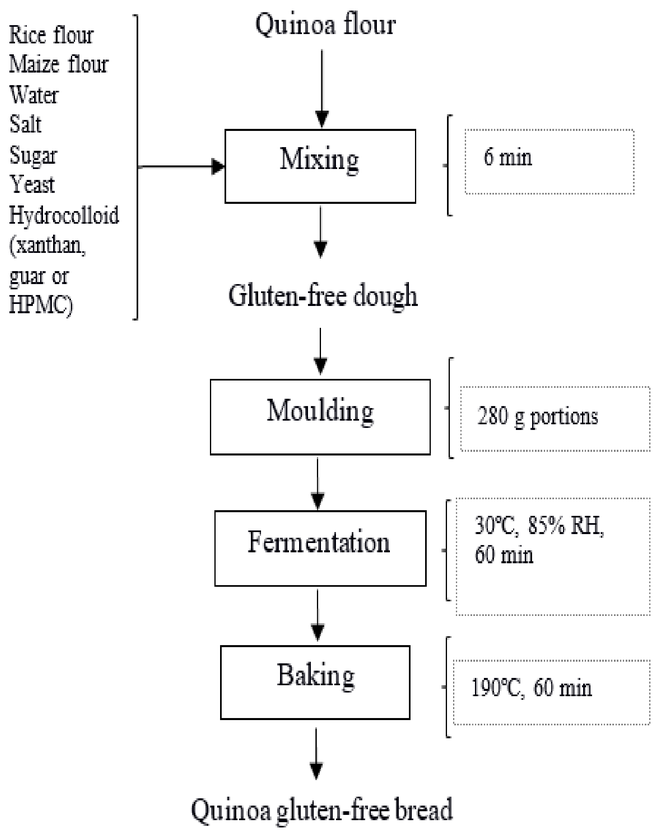

Fig. 1: Process of gluten-free bread with quinoa flour

Image analysis of bread crumb

- Image analysis
  - Bread slices
  - Mean cell area (mm^2)
  - cell density (number of cells/mm^2)
  - cell size uniformity (nº cells <=5 mm^2 / nº cells >5 mm^2)
  - void fraction
  - mean cell aspect ratio
  - mean cell solidity

Statistical analyses

- R software version 3.3.1
- Principal component analysis (PCA)
- Packages
  - *FactoMineR*
  - *factoextra*

Conclusions

1. The PCA revealed that the information contained in the 24 variables could be effectively decomposed into two major components, one related to bread crumb porosity and hardness (45%), and the other to batter viscosity (32%);
2. The XG and GG produced batter and bread of similar quality, although GG, particularly at high dose, produced smaller loaves of harder and more resilient and cohesive crumb than XG;
3. Compared to XG and GG, HPMC yielded batters of higher stickiness, consistency and firmness, producing loaves of higher volume, softer crumb, and larger pores.

Results and discussion

❑ The first PC accounted for 45% of the variability, and was:

- Highly correlated with loaf specific volume (r=-0.90), the image grain features of void fraction (r=-0.96), mean cell density (r=0.92), mean cell area (r=0.88), mean cell solidity (r=0.85), TPA chewiness (r=0.92), hardness (r=0.88), and dough stickiness (r=-0.84).
- Moderately correlated with cell size uniformity (r=0.79), baking loss (r=-0.78), and TPA cohesiveness (r=0.69), adhesiveness (r=-0.68) and resilience (r=0.61; Fig. 2, top).

❑ The second PC accounted for 32% of the variation, and was:

- Highly correlated with the batter BE properties of viscosity (r=0.96), cohesiveness (r=0.92), consistency (r=-0.94) and firmness (r=-0.95), the batter STK properties of cohesiveness (r=0.88) and adhesion (r=0.80), and bread crumb pH (r=0.83) and a_w (r=0.78).
- Moderately correlated with the bread crumb TPA property of springiness (r=0.76; Fig. 2, top).

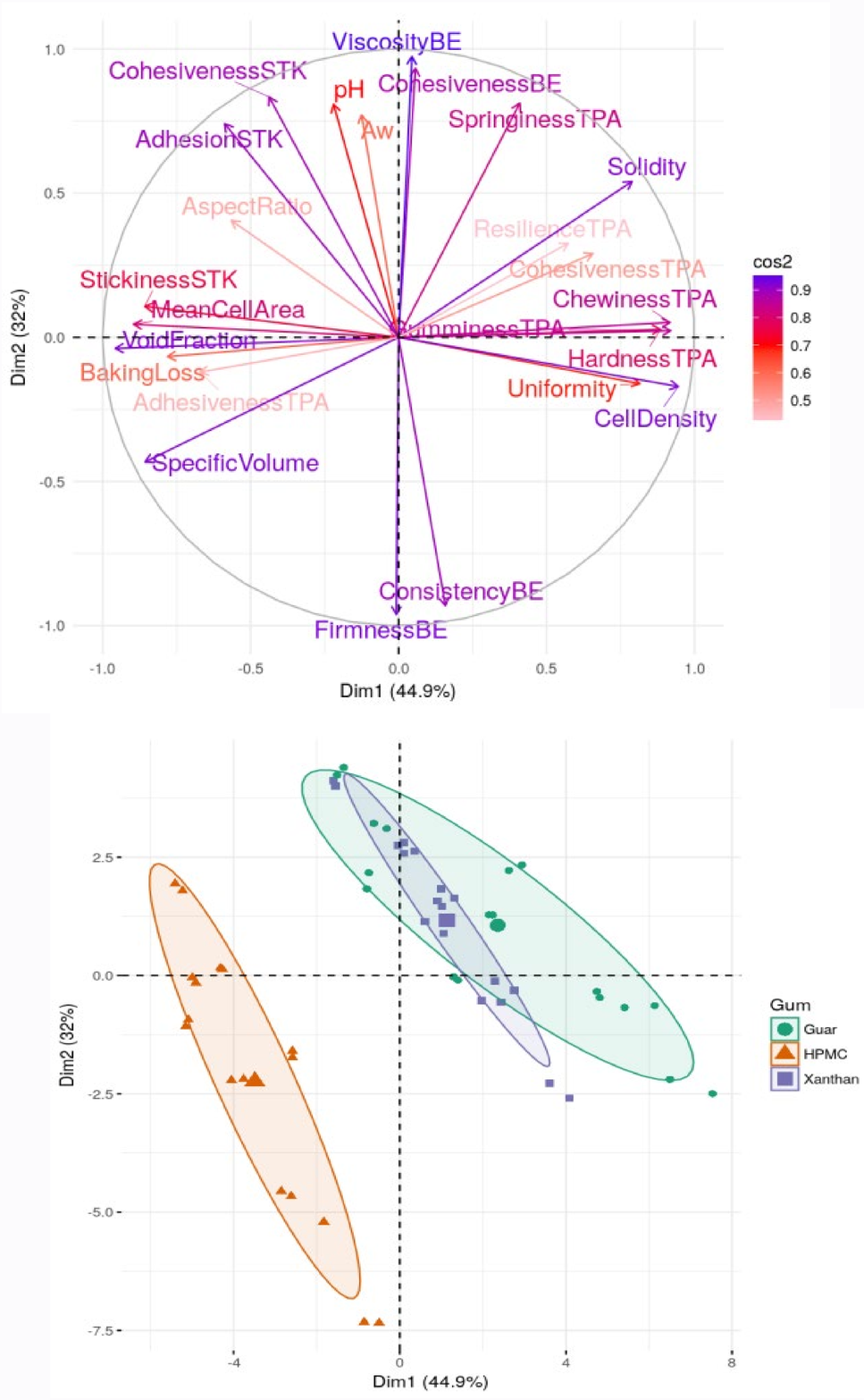

Fig. 2: Two-factor map of bread quality features (top) and projection by gum type (bottom)

❑ Projections of the individual scores on the 2D-map of quality attributes (Fig. 2, bottom) revealed that XG and GG produced gluten-free batter and bread of comparable quality. Although GG, particularly at high dose, produced smaller loaves of harder and more resilient and cohesive crumb than XG.

❑ Comparing with XG and GG, the use of HPMC yielded batters of higher stickiness, consistency and firmness, which, when baked, produced loaves of higher volume, softer crumb, and larger and more elongated.

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