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Analysis of the addition of turmeric on the rheological behavior of bread dough

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1. Introduction

Salt has an important role in the development of the gluten network, especially for bread. Salt not only improves the dough rheology but also increases the gluten network stability, and affects fermentation rate consequently reducing gas production (Hutton, 2002). Lynch et al., (2009) found that the absence of salt significantly affects the breads rheology and quality. However, prominent results were found with 0.3% up to 1.2% of salt. The same study showed which means that it is possible to have a standard quality bread with a low percentage of salt, nevertheless, organoleptic characteristics do vary.

Turmeric (*Curcuma longa* L.) is a spice traditionally used in East Asia. This spice is extracted from the roots and it is used as a food dye or condiment. It has strong organoleptic qualities given that it has an intense yellow color and a peppery flavor (Azmi & Bhat, 2016). Turmeric is considered a functional food since it has anti-inflammatory, anti-microbial and hypocholesterolemic properties. Turmeric powder has high mineral content such as potassium, sodium and iron (Sasikumar, 2012). The objective of this study was to use turmeric in bread and understand how the partial replacement of salt for turmeric will affect the bread doughs rheology.

2. Materials and methods

2.1. Bread Formulation

Bread was made with a sweet dough formulation. The base formulation was 100 % bread flour (a Baker´s base was used), 20 % white sugar, 8 % fresh yeast, 6 % fat and 1 % salt. Water was adjusted with the values from Mixolab. Three formulations were analyzed: one with 0 % turmeric and 1% sodium chloride; one with 0.75 % of turmeric and 0.25% of sodium chloride; one with 0% salt and 0% turmeric. The turmeric used was *Curcuma longa* L. in powder presentation.

2.2. Experimental Design

The design used was a randomized complete design with one factor and three levels. Each formulation was analyzed twice. The values were compared with Anova and Tukey´s test with a significance level of 5 %.

2.3. Bread dough analysis

Mixolab was used to analyze the gluten network development in bread dough. The curves were analyzed for each formulation. Mixolab parameters that were analyzed are: hydration (%) which represents the amount of water added to reach the maximum torque of the dough, stability line (min) which indicates how strong is the dough until the gluten breaks and the C2 value that represents how the protein structure weakens while temperature and force increases (Dubat, 2010; Schmiele et al., 2017).

3. Results and discussion

Mixolab curves are showed in Figures 1, 2 and 3. Mixolab results showed that water absorption in all formulations had a significant difference ($p<0.05$). The formulation with 0 % salt (sodium chloride) had the highest percentage, 65.30 %, while 0.75 % turmeric had a hydration of 63.9 ± 0.57 % and the formulation with 1% salt had the lowest hydration, 61.7 %. The fact that water absorption reduced while salt increases is explained with a theory regarding molecules interactions. It is believed that water absorption decreases when salt percentage increases because sodium chloride ions generates competition with proteins to absorb water molecules. The interaction between sodium chloride and wheat proteins reduces the reaction probability of proteins with water molecule (Beck et al., 2012).

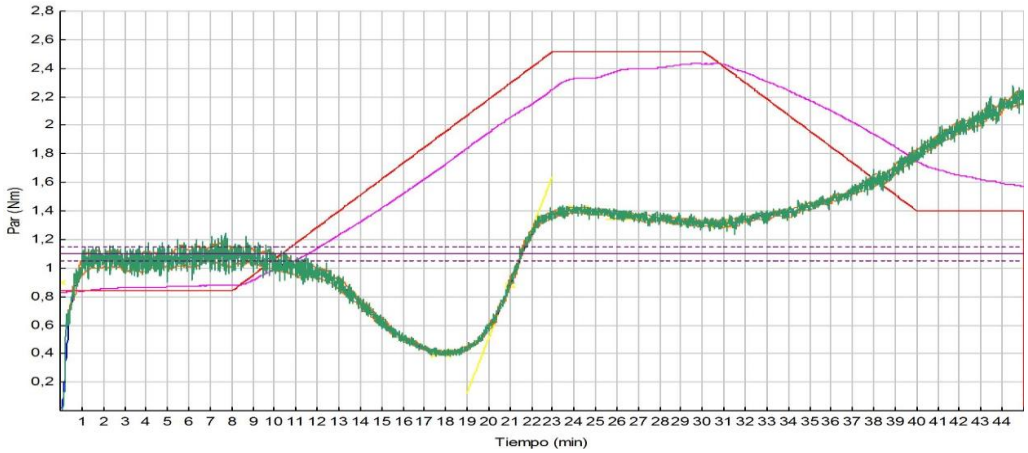

Figure 1 *Mixolab Curve for formulation with 1% salt*

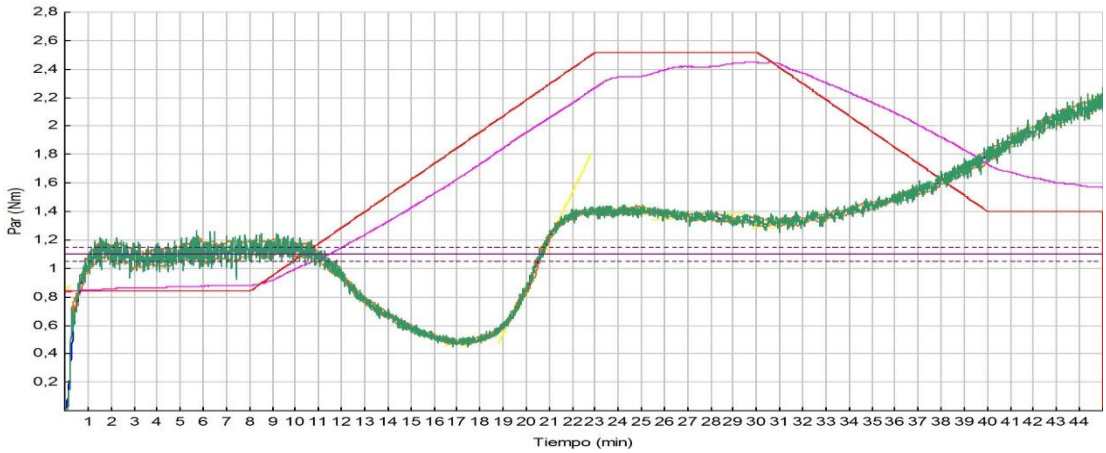

Figure 2 *Mixolab curve formulation with 0,75% turmeric and 0,25% salt*

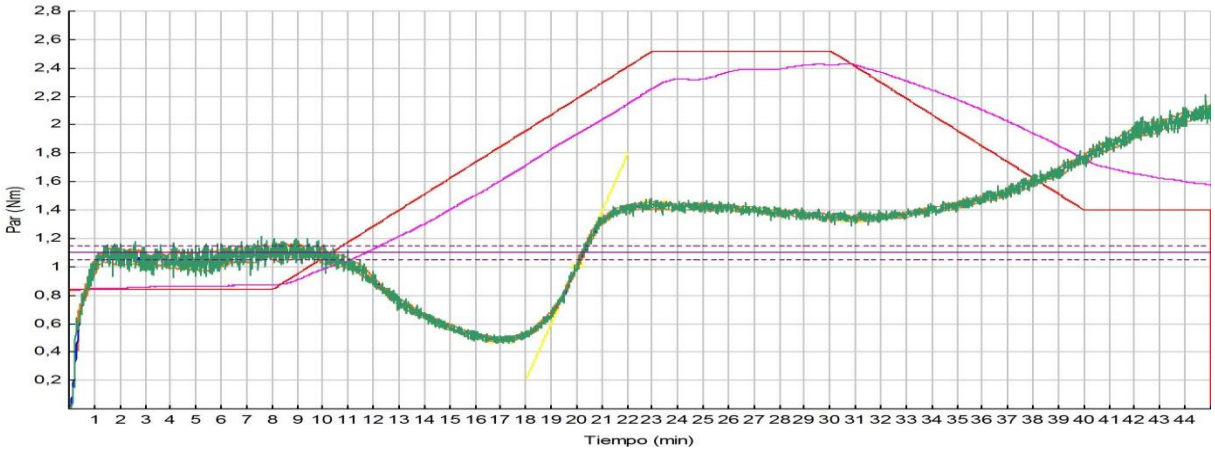

Figure 3 *Mixolab curve formulation with 0% salt*

The stability time had no significant difference between the tests. The test of 0.75 % of turmeric had the longest stability of 9.047 ± 0.25 minutes, 0 % salt had a stability of 8.75 ± 0.247 minutes and 1 % salt had a stability of 7.17 ± 0.73 minutes. The theory states that less salt should result in less stability of the dough since the gluten network is strengthen by salt (Beck et al., 2012). Also, salt is related to increase the mixing time of the dough, which is contrary to the results (Beck et al., 2012; Danno & Hoseney, 1982). However, turmeric has high sodium content which could contribute to the gluten network strength (Sasikumar, 2012).

The 0.75 % turmeric test and 0% sodium chloride had no significant difference in the C2 value while the 1 % salt had a significant difference with the other two formulations. The values were 0.500 ±0.013 Nm for 0 % salt, 0.476 ± 0.010 Nm for 75 % turmeric and 0.390 ±0.020 Nm for 1 % salt. C2 is related to the strength of the protein network. The significant difference with the 1 % salt could be due to how salt affects directly the protein network since in increases interactions between the proteins which strengthens the gluten network (Avramenko et al., 2018).

4. Conclusion

Bread dough with 1 % salt, 0 % salt and 0.75 % turmeric: 0.25 % of salt did show different rheological properties. Water absorption had a significant difference in the three formulations due to molecular interactions with water molecules. There was no significant difference in the dough´s stability time with Mixolab results. C2 values had a significant difference due to sodium chloride's interaction with gluten proteins.

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