Effects of glycerol and salt on the mechanical macromolecular and superstructural properties of corn tortillas

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ABSTRACT

Traditional corn tortillas are produced from dehydrated masa and water, and have a very short shelf-life of 1-3 days. Commercial corn tortillas use carboxymethylcellulose and antimicrobial agents (propionates and benzoates) to delay staling and inhibit microbial spoilage, respectively. These additives are not only expensive, but they impart off-flavors to the product. The objective of this study was to investigate the mechanical molecular properties of glycerol and salt in corn tortillas using Dynamic Mechanical Analysis (DMA) and the superstructural effects using an Instron Universal Testing Machine. Corn tortillas with and without glycerol and salt were adjusted to 37-55% moisture and measured in the DMA. As moisture content decreased, stiffness of the samples increased for all tortillas. The glycerol and salt tortillas exhibited a more narrow temperature range for the change in stiffness suggesting that these additives may provide a more homogeneous water distribution within the samples, which may delay staling in storage studies. The tortillas were also measure on a superstructural level using an Instron and revealed an inverse relationship of stiffness with moisture for all treatments. Therefore, on a superstructural level all tortillas exhibited similar stiffness regardless of the additives. Therefore, the glycerol and salt textural effects are mainly observed on a molecular level.

INTRODUCTION

Tortillas represent the fastest growing segment in the baking industry.

Fresh, homemade tortillas become stale after only a couple of hours.

Corn tortillas are commercially made with CMC, proprionates and sorbates to maintain a longer shelf-life on a textural and microbial standpoint.

An alternative to these additives would be the use of polyols such as glycerol.

OBJECTIVE

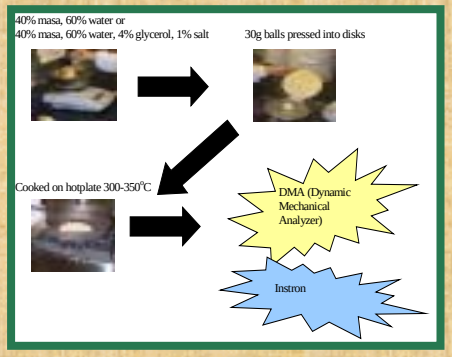
Characterize the mechanical molecular properties of glycerol and salt in corn tortillas using Dynamic Mechanical Analysis (DMA) and superstructural effects using the Instron Universal Testing Machine.

REFERENCES

Peleg M. (1993) Mapping the stiffness-temperature-moisture relationship of solid biomaterials at and around their glass transitions. *Rheol Acta* 32:575-580

Vodovotz, Y., Hallberg, L.M. and Chinachoti, P. (1996) Characterization of DMA results for aging and drying of standard white bread. *Cereal Chem.* 73, 264-270

MATERIALS & METHODS



Dynamic Mechanical Analyzer (DMA)

Measures the storage modulus or E' (stiffness) and damping or tan δ (energy dissipation) properties of materials as they are deformed under a periodic stress with an increasing temperature.

These measurements provide quantitative and qualitative information about the performance of the corn tortillas, which exhibit temperature effects on their macromolecular mechanical properties because of their viscoelastic characteristics.

Instron

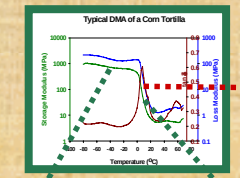
The Instron measures the stress and strain of the corn tortilla on a superstructural mechanical level at ambient conditions. From these measurements, a modulus (stiffness) of the sample can be obtained. The tortillas are placed in a tension clamp and the stress and strain needed to break the tortilla is measured.

CONCLUSIONS

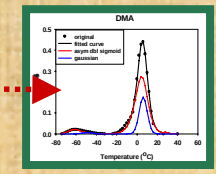
Corn tortillas analyzed on a macromolecular mechanical level using the DMA illustrated that the glycerol and salt may provide a more homogenous component distribution throughout the tortillas. This effect may have favorable implications in future staling studies. The data obtained characterized the tortillas having a more narrow range of phase transition in the glycerol salt tortillas than the tortillas without additives. All tortillas exhibited a higher degree of stiffness as moisture content decreased but the stiffness values were lower for the glycerol/salt tortillas.

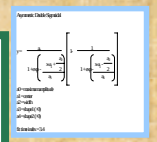
An inverse relationship between moisture content and the degree of stiffness was observed for all tortillas, regardless of additives, as shown in the data collected from the Instron. Also, the degree of stiffness in both tortillas were similar in the tortillas with additives and the tortillas without additives. Therefore, the glycerol and salt textural effects were mainly observed on a macromolecular level.

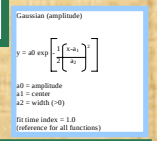
RESULTS & DISCUSSION

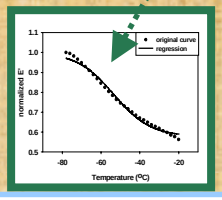


The tan delta was deconvoluted using an asymetric double sigmoidal equation and a gaussian equation to better characterize the transition regions.

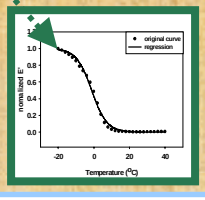




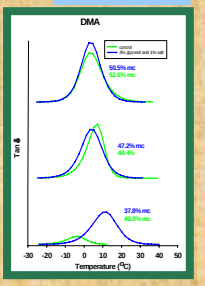




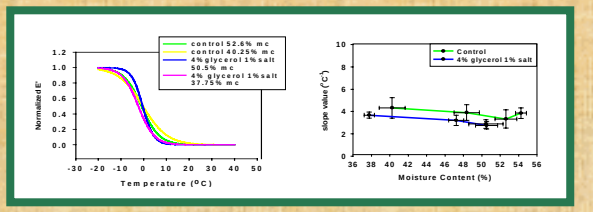
A modified fermi equation (Peleg 1993) was used to fit the E' at ~80°C to ~20°C and was shown as follows: f=(1-b)/(1+Exp((x-T)/a))+b



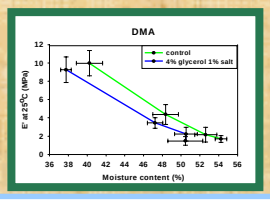
A modified fermi equation (Peleg 1993) was used to fit the E' at ~20°C to 40°C and was shown as follows: f=1/(1+Exp((x-T)/a))



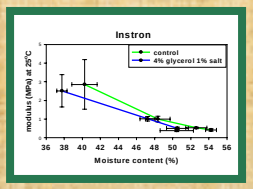
The asymmetric double sigmoidal equation was the main event in all of the deconvolutions. In the tortillas with glycerol and salt, the peak dropped slightly with moisture content and the transition shifted to the right. In the tortillas without glycerol and salt, the peak decreased greatly with a decrease in moisture content and shifted to the left. The more constant transitions with the glycerol and salt may indicate that the water in the tortillas was distributed more evenly.



The slopes of all tortillas decreased with increasing moisture content. The tortillas with glycerol and salt had a smaller slope value with all levels of moisture content as compared with the control. The slope value indicates the range of the temperature that a transition occurs. Since the range was smaller in the tortillas with glycerol and salt, the transition was sharper and this may be due to a more homogenous distribution of the tortilla components.



The DMA storage modulus (E') is a measurement of the stiffness of the sample. With both tortillas, as moisture content decreased, the stiffness increased. The tortillas containing glycerol and salt maintained a lower degree of stiffness than the tortillas without the additives with decreasing moisture contents.



On a superstructural level, the Instron illustrated an increase in stiffness due to a decrease in moisture content in both samples. The glycerol salt tortillas exhibited a slightly lower degree of stiffness than the tortillas that did not contain glycerol or salt.