Effects of high pressure processing on the physico-chemical properties of Corn Tortillas

E. Clubbs, T.H. Shellhammer, Y. Vodovotz

ABSTRACT

Traditional corn tortillas are produced from dehydrated masa and water and have a very short shelf-life of 1-3 days, due to microbiological spoilage. High pressure processing (HPP) is an effective non-thermal processing technique for inactivating vegetative microorganisms in liquid and solid food systems, and is potentially useful for extending the shelf-life of fresh tortillas. The objective of this study was to investigate the physico-chemical effects of HPP on corn tortillas. Fresh corn tortillas were individually vacuum packaged in high-barrier flexible pouches and pressurized over a range of pressures and times, from 500 Mpa to 800 MPa and 1 to 10 minutes, respectively. Molecular and macroscopic changes in the tortillas were measured using differential scanning calorimetry (DSC), Thermogravimetric analysis (TGA), dynamic mechanical analysis (DMA), and Instron mechanical analysis. High pressure did not affect tortilla strength or extensibility. The final moisture content significantly decreased with increasing pressure treatments. The percent "unfreezable" water (DSC) was not affected by HPP treatment. Instron analysis illustrated an increase in stiffness following processing at 500 MPa and 800MPa for 10minutes.

INTRODUCTION

Tortillas represent the fastest growing segment in the baking industry.

Fresh, homemade corn tortillas become stale after only a few hours and are subject to mold, yeast, and bacterial growth because of their high moisture content.

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

An alternative to these additives would be the use of high pressure processing.

High pressure processing (HPP) is an effective non-thermal processing technique for inactivating vegetative microorganisms and many deleterious enzymes in liquid and solid food systems.

OBJECTIVE

The objective of this study was to investigate the physico-chemical and textural properties of corn tortillas treated with high pressure.

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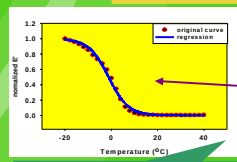
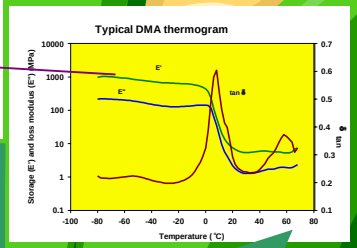
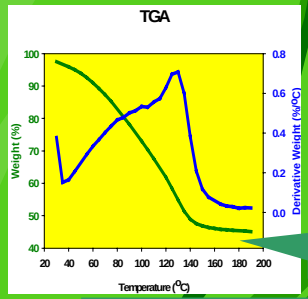
MATERIALS & METHODS



A modified Fermi equation (Peleg, 1993) for fitting E' (T) –20ºC to 40ºC:
f=(1-b)/(1+Exp((x-T)/a))+b
a=slope, T=midpoint Temp (ºC), b=constant



DMA 2980 TA Instruments, New Castle, Delaware
Tension Film Clamp
Multi frequency mode
Temperature Range: -80-100 degrees C
Temp. Ramp 2ºC/min
Frequency 1.0Hz

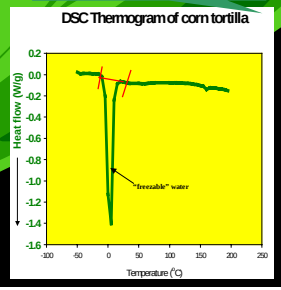


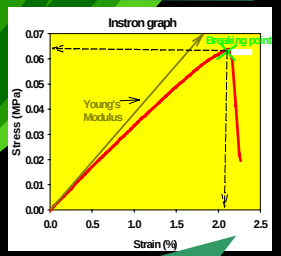
TGA 2960 TA Instruments, New Castle, Delaware

Temperature range: 25-200ºC
Temp. ramp 20ºC/min
High resolution: 3ºC

DSC 2920 TA Instruments, New Castle, Delaware

Temperature range: -50-200ºC
Temperature ramp: 5ºC/min
Pans: high volume o-ring
Empty reference pan





Instron 5542 Instron Corporation, Canton, Mass.

Ambient conditions
Upwards crosshead speed of 2mm/min
Tension clamp
Measures stress (MPa), Strain (%), and modulus (MPa)

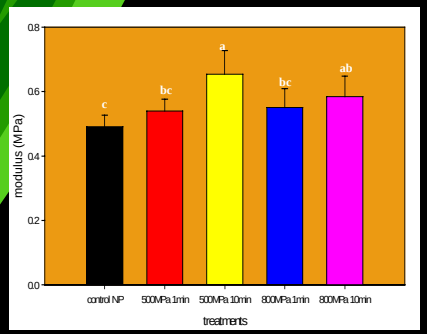
RESULTS & DISCUSSION

Table 1. F-values obtained from statistical analysis, general linear model (GLM) of DMA, TGA,DSC and Instron analysis for the control and HP tortilla samples. (* = significant at p<0.05, *** = signifcant at p < 0.001).

	Mean square error	F-value
DMA E' slope (a)	0.245	1.69
DMA E' midpoint T (°C)	2.043	2.13
TGA weight loss	0.595	5.50*
DSC FW(%)	15.890	1.54
Instron, breaking stress (MPa)	0.00002	1.75
Instron breaking strain	0.336	1.01
Instron Young's modulus (MPa)	0.0004	15.10***
Moisture loss (%)	1.396	0.84
Degree of freedom	5	4

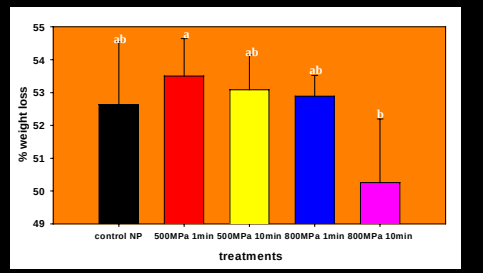
The only parameters affected by HP were TGA % weight loss and the Instron modulus.

Figure 1. Instron modulus of corn tortillas treated with pressure. Means with the same superscript are not significantly different (a = 0.05). Error bars represent ± one standard deviation, n = 2.



High pressure was found to affect the Young™s modulus, or stiffness, of the corn tortilla. Tortillas pressurized at 500 MPa or 800MPa for 10 minutes were significantly stiffer (p < 0.05) than control tortillas.

Figure 2. TGA weight loss of corn tortillas treated with pressure. Means with the same superscript are not significantly different (= 0.05). Error bars represent ± one standard deviation, n = 2.



Weight loss occurred from room temperature to ~ 140 °C (solid line, TGA graph) and averaged 52% ± 2% for all samples. TGA moisture contents in this study were similar to those determined by the vacuum weight loss method. TGA resulted in significant differences between the 500 MPa/1 min treatment (53.5%) and the 800 MPa/10 min (50.2%).

CONCLUSIONS

Moisture was found to have a bimodal distribution in the tortilla (TGA), with easily removed water comprising 65% of the water content.

High pressure influenced the moisture content in the samples but did not affect moisture distribution.

The stiffness of the tortillas was not affected by HP on a macromolecular level (DMA) but on a superstructural level (Instron), long hold times at both 500 MPa and 800 MPa caused an increase in the Young™s modulus.

These results indicate that HP can be used to process corn tortillas without significantly affecting their moisture distribution or stiffness; two very important physical properties. Long hold times at pressure may contribute to macroscopic changes in tortilla texture.

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