

ABSTRACT

Freezing dough allows for the production of fresh baked products while minimizing equipment costs. Currently, there is a lack of frozen dough products on the market containing significant quantities of soy protein. Recently, a soy containing bread was produced at The Ohio State University that meets the FDA heart healthy claim. In order to develop a high soy containing frozen dough, the impact of low temperature storage on the physico-chemical properties of the dough needed to be assessed. The objectives of this study were to characterize the effects of adding 30% soy on the physico-chemical properties of frozen dough compared to standard frozen wheat dough. Wheat and 30% soy doughs were prepared and placed in a -40°C freezer for 24 hours, transferred to a -10°C freezer for 2 weeks, and then thawed prior to analysis. Thermal analysis techniques (DMA, DSC, and TGA) were used to evaluate the state of components in the dough. DMA showed a major transition for both doughs (fresh and frozen) centered at 2.5°C covering a temperature range of 45°C for soy and centered at 7.5°C covering a temperature range of 35°C for wheat. The greater temperature range of the soy dough transition implies a greater heterogeneity of its components as compared to wheat dough. DSC confirmed these transitions to be mostly ice melting although an additional transition may be present in soy containing doughs. The % “unfreezable” water was significantly higher in soy containing doughs (~16-17%) vs. wheat doughs (~13-15%) with little change during storage. Freezing of soy and wheat dough had little impact on water distribution and material properties compared to unfrozen samples. Frozen soy doughs retained a greater amount of water which may help ameliorate the deleterious effects to the final baked loaf of low temperature storage.

INTRODUCTION

Incorporation of soy into bread would provide a health benefit to consumers although the addition of soy to baked products has been found to result in a beany flavor and crumbly texture.

A soy bread was recently developed at OSU to meet the FDA health claim whereby consuming 6.25g of soy protein (per serving) along with a diet low in saturated fat and cholesterol may reduce the risk for heart disease.

Over the past several years the baking industry has implemented freezing into their manufacturing practices; while vast improvements have been made, some problems remain regarding texture and flavor.

One of the key components in the stability of frozen dough is water.

Thermoanalytical techniques were found to be particularly suitable in characterizing the state of water and other components in a system.

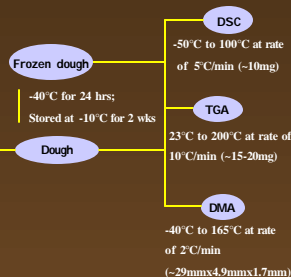
OBJECTIVE

To characterize the effects of added soy on the physico-chemical properties of frozen dough.

MATERIALS & METHODS

Ingredients	% in wheat dough	% in soy dough
Wheat flour	54.3	17.5
Water	37.7	45.3
Sugar	4.0	4.5
Salt	1.0	0.9
Crisco shortening	2.1	1.7
Yeast	0.9	1.0
Gluten	-	2.3
Dough conditioner	-	0.2
Soy milk	-	6.6
Soy flour	-	19.9

Table 1. List of ingredients.



RESULTS & DISCUSSION

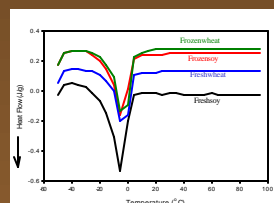


Figure 5. Comparisons of DSC thermograms of the different treatments. The peak around 0°C for all treatments was used to calculate FW, FW and UFW was higher in soy samples than wheat (table 2).

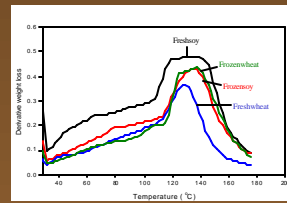


Figure 6. TGA thermogram comparing all treatments. All samples showed a bimodal distribution for moisture loss. Results of best fit of the derivative curves are shown in Table 3.

Treatment	MC (TGA)	FW (DSC)	UFW (MC-FW)
Fresh soy	43.9 ±1.1	28.2 ±3.8	15.7
Frozen soy	37.9 ±4.5	20.8 ±2.7	17.1
Fresh wheat	31.6 ±4.5	18.7 ±0.3	12.9
Frozen wheat	33.3 ±3.2	18.0 ±2.1	15.3

Table 2. Comparisons of moisture content, % “freezable” water, and % “unfreezable” water. Both the fresh and frozen products containing soy have a higher moisture content and % “unfreezable” water than their wheat counterparts implying greater retention of the water.

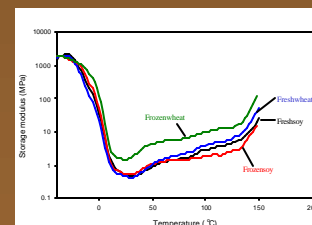


Figure 7. Comparison of storage moduli (E') obtained by DMA. The drop in stiffness around 0°C is due to, at least in part, ice melting as confirmed by DSC.

Treatment	a value (slope)	T value (critical temp.) (°C)
Fresh soy	4.0 ±0.36	-19.9 ±0.58
Frozen soy	8.7 ±0.46	-26.7 ±1.21
Fresh wheat	4.7 ±0.25	-12.8 ±0.85
Frozen wheat	10.5 ±0.68	-21.9 ±2.64

Table 4. Results of the E' (T) curve of the DMA with a modified Fermi equation. For both wheat and soy, samples became more heterogeneous and transitioned at lower temperatures with freezing.

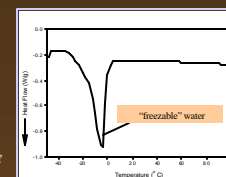


Figure 1. Typical DSC thermogram.

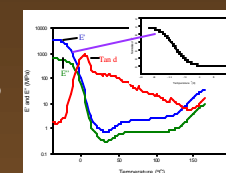


Figure 2. Typical DMA thermogram. The Storage Modulus (E') measures the stiffness of the sample. A Modified Fermi equation ($E' = (1-b)/(1 + \exp(-(x-T)/a)) + b$) (Pegel 1993) was used to better characterize the E' (insert).

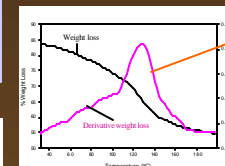


Figure 3. Typical TGA thermogram.

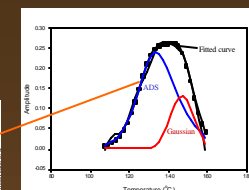


Figure 4. To better characterize the TGA curve it was best fit with a combination of a Gaussian and Asymmetric double sigmoidal (ADS) curve (Fessas and Schiraldi 2000).

Treatment	ADS peak temp (°C)	ADS area	Gaussian peak temp (°C)	Gaussian area
Fresh wheat	109	34	133	66
Fresh soy	120	52	142	48
Frozen wheat	133	33	146	67
Frozen soy	126	25	136	75

Table 3. Parameters describing the deconvolution results of the TGA derivative curves (Figure 6). In all cases, except the fresh soy, most of the water loss (Gaussian area) occurred at a later temperature (~133-146°C). The fresh soy lost most of its water around 120°C.

REFERENCES

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

Fessas and Schiraldi. (2000) Water properties in wheat flour dough I: Classical thermogravimetry approach. *Food Chemistry* 72: 237-244.

Conclusions

Freezing soy containing doughs decreased its MC and % FW while no such changes were found in wheat doughs.

Soy doughs (fresh and frozen) had a higher MC, FW, and UFW content compared to their wheat counterparts.

Water loss was not homogeneously partitioned within any of the doughs and occurred at higher temperatures for soy containing doughs, indicating more mechanically entrapped water.

Freezing of both wheat and soy doughs increased the heterogeneity and the transition temperature of the system (E', DMA).

Addition of soy to a dough significantly changes the state of water in the system with and without freezing.