



Effect of frozen storage on the conformational, thermal and microscopic properties of gluten: Comparative studies on gluten-, glutenin- and gliadin-rich fractions

Pei Wang^{a,b}, Lei Xu^{a,b}, Mehdi Nikoo^{a,b}, Denis Ocen^{a,b}, Fengfeng Wu^{a,b}, Na Yang^{a,b}, Zhengyu Jin^{a,b}, Xueming Xu^{a,b,*}

^a State Key Laboratory of Food Science and Technology, Jiangnan University, 1800 Lihu Avenue, Wuxi 214122, Jiangsu Province, PR China

^b School of Food Science and Technology, Jiangnan University, 1800 Lihu Avenue, Wuxi 214122, Jiangsu Province, PR China

ARTICLE INFO

Article history:

Received 13 March 2013

Accepted 24 May 2013

Keywords:

Wheat gluten proteins

Thermal properties

Conformational analysis

Microstructure

Frozen storage

ABSTRACT

The effect of frozen storage on the water sorption capability, water mobility, secondary structure, thermal and microscopic properties of gluten-, glutenin- and gliadin-rich fractions were investigated. Lower water sorption capability was observed for samples after frozen storage, suggesting that more hydrophobic moieties were exposed. Conversions of α -helix structure to β -turn structures and specific β -sheet structures were observed in the secondary structure analysis of gluten- and gliadin-rich fractions. Frozen storage induced higher water mobility in hydrated gluten proteins. Similar changes were observed in gluten-water and gliadin-water systems, implying that the changes were primarily attributed to subdued gliadin-water interactions and gliadin can stabilize glutenin network to confine the water mobility. Meanwhile, thermo gravimetric analysis (TGA) and differential scanning calorimetry (DSC) showed that thermal degradation temperature decreased while thermal denaturation stability increased in gluten- and glutenin-rich fractions with the increasing time of frozen storage. However, the enthalpies of all the gluten proteins decreased, indicating more disordered structures in the aged gluten proteins. The micrographs of scanning electron microscopy (SEM) also confirmed more disordered and weak structures in gluten- and glutenin-rich fractions induced by frozen storage. Furthermore, consistent changes in gluten-, glutenin- and gliadin-rich fractions indicated that the variations in conformational, thermal and microscopic properties of gluten might originate from glutenin and gliadin upon frozen storage.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

For the common bakery products, wheat gluten is one of the most important constituents, determining the unique baking quality of wheat by conferring water absorption capacity, cohesivity, viscosity and elasticity on dough. Gluten can be further divided into two fractions according to the solubility in alcohol-water solutions: the soluble gliadins and insoluble glutenins (Wieser, 2007). Gliadins are monomeric proteins with molecular weight (Mw) ranging from 3 to 8×10^4 Da, whereas glutenin are interchain disulfide-linked polymers with a wide Mw distribution from 10^5 to 10^7 Da (Wahlund, Gustavsson, MacRitchie, Nylander, & Wannerberger, 1996).

* Corresponding author. State Key Laboratory of Food Science and Technology, Jiangnan University, 1800 Lihu Avenue, Wuxi 214122, Jiangsu Province, PR China. Tel./fax: +86 510 85917100.

E-mail addresses: whiteblair1991@yahoo.com (P. Wang), xmxu@jiangnan.edu.cn (X. Xu).

In gluten, glutenin forms a network and interacts with gliadin by non-covalent forces, mainly hydrogen bonds (Lamacchia et al., 2000). The unique viscoelastic properties of gluten are ascribed to the viscous gliadin and elastic glutenin respectively. Overall, the viscoelastic three-dimensional gluten network is stabilized by covalent disulfide (SS) bonds and superimposed by non-covalent interactions such as hydrogen bonds, ionic bonds and hydrophobic bonds (Domenek, Morel, Redl, & Guilbert, 2003). Due to the crucial role of special network formed upon hydration in bread making, the water sorption capability and water mobility in gluten dough is of great importance. The gluten matrix is the reminder of water. The water adsorption capacity and water mobility of our products depend greatly on the distribution of polar groups, accessibility of these groups to water, relative strength of water–water and water–macromolecule interactions, degree of crystallinity of the matrix and relative humidity conditions (Esselink, Aalst, Maliepaard, & Duynhoven, 2003; Roman-Gutierrez, Guilbert, & Cuq, 2002).