



Influence of acetylated potato starch on the properties of dumpling wrapper



Jia Mi, Yan Liang, Yanmin Lu, Congping Tan, Bo Cui*

School of Food and Bioengineering, Qilu University of Technology, Jinan, Shandong 250353, China

ARTICLE INFO

Article history:

Received 4 December 2013

Received in revised form 11 February 2014

Accepted 24 February 2014

Available online 24 March 2014

Keywords:

Acetylated potato starch

Dumpling wrapper

Crack rate

Moisture content

Microstructure

ABSTRACT

Physicochemical properties of dumpling wrappers with different levels of acetylated potato starch (APS) were measured. Differential scanning calorimetry (DSC) indicated that the presence of APS significantly reduced the freezable water content (FWC) of the system. For the systems, the mobility of the water which was measured by pulse nuclear magnetic resonance (NMR) demonstrated that the existence of APS reduced the relaxation time. Whereas, the centrifugation measurement indicated that the water holding capacity (WHC) values of wheat flour with APS were higher than the control. Scanning electron microscope (SEM) was used to examine the micromorphology of dumpling wrappers.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

For the decades, modified starch was famous for lower retrogradation, better rheological behavior, texture and cooking properties (Atichokudomchai and Varavinit, 2003; Dapčević Hadnađev et al., 2013; Karaoglu et al., 2001; Miyazaki et al., 2008; Song et al., 2010b). Acetylated starch was made by replacing the hydroxyl groups (OH) of native starch with ester groups (Yu and Yang, 2003). Acetylation occurs in all the amorphous regions and also at the outer lamellae of crystalline regions, rather than throughout the crystalline regions of the whole starch granule (Chen et al., 2004). As the granule structure becomes increasingly disrupted, more starch polymers, especially amylopectin, disentangle, which exposes more hydroxyl groups to water, resulting in an increased starch–water interactions (Aktaş and Genççelep, 2006). Acetylated maize, potato and rice starches suggest a significant increase in swelling power and solubility upon acetylation in all these starch types, the extent of this increase was observed to be higher for potato starches (Singh et al., 2004). The maximum permitted levels of substitution for acetylated starch is 2.5% (Singh et al., 2007). Most of the physicochemical and mechanical properties of acetylated starch strongly depend on the degree of substitution (Korhonen et al., 2000). As the degree of substitution increases from near 0 to 3.0, the nature of the

acetylated starch changes from hydrophilic to more hydrophobic and, simultaneously, the inter-particle bonding capacity increased greatly (Korhonen et al., 2002).

Quick-frozen dumplings contributed an important part of the ready-to-eat processed food in China. However, the changing of quality and structure for the dumplings during storage and transportation resulted in the appearance of cracks and color browning. This may be partly related to water changing during cold preservation. Structural changes to the gluten network occur during freezing and storage seems to be related to freezing out and migration of water during freezing (Yi et al., 2009). Baier-Schenk et al. (2005) concluded that growth of ice crystals leads to a redistribution of water in the dough, which in turn affects the properties of polymeric compounds in dough and reduces the baking performance of pre-fermented frozen dough. Therefore, water variety was studied to understand the influence of starches on the crack rate of dumpling wrapper.

Water is one of the most important components in flour product system. During cold preservation, it partly became ice and the amount of ice was ascribed to the difference of dough formulation and sample preparation (Baier-Schenk et al., 2005). Differential scanning calorimetry (DSC) is widely used to determine the frozen water content (FWC) during freezing for the frozen food (Baier-Schenk et al., 2005; Guan et al., 2011; Lodi and Vodovotz, 2008). FWC is usually determined by the melting enthalpy of ice below 0°C. Simultaneously, the distribution and mobility properties of water attracted researchers' attention. A considerable number of papers have reported that the mobility of water in food systems can be determined by measuring the transverse relaxation time

* Corresponding author at: Qilu University of Technology, Daxue Road, Changqing District, Ji'nan City, Shandong Province 250353, China. Tel.: +86 18660811718; fax: +86 531 89631728.

E-mail address: cuibopaper@163.com (B. Cui).

(T_2) with pulse Nuclear Magnetic Resonance (NMR) (Assifaoui et al., 2006; Carini et al., 2010; Kim and Cornillon, 2001; Raun et al., 1999). Generally, T_2 relaxation of complex food showed multi-populations, each population can be interpreted as different water regions.

Modified starches were widely used as a dumpling improver and can reduce crack rate of dumpling (Liuzhi et al., 2006; Song et al., 2010a; Yanqi et al., 2008). Several papers have been published concerning the effect of modified starch on frozen dough behavior (Dapčević Hadnađev et al., 2013; Miyazaki et al., 2008; Ziobro et al., 2012). Less work was focused on the influence of acetylated starch on quick frozen dumplings. The objective of this work was to characterize the influence of acetylated potato starch (APS) on properties of dumpling wrapper and discuss the impact on the crack rate of dumplings wrappers.

2. Materials and methods

2.1. Materials

Premium household wheat flour (moisture content is 12.3%, ash is 0.53%, protein content is 11.0%) was bought from Qingdao Biomate Foodstuff Co. Ltd. Farinograph were determined according to AACC method 54-21. The acetylated potato starch (with acetyl content and DS is 0.45 and 1.70%, respectively) was purchased from Roquette (France).

2.2. Preparation

The wheat flour was mixed homogeneously with APS (the addition is 5%, 7.5%, 10%, 12.5% and 15% (w/w)) and abbreviated as APS-5, APS-7.5, APS-10, APS-12.5 and APS-15, respectively. Dumpling wrapper was prepared by 300 g of mixed wheat flour and 120 g of distilled water (with 3 g of NaCl) (Liuzhi et al., 2006). The flour and distilled water were mixed by a dough mixer for minutes according to the farinographic development time and rest for 10 min. After resting, the dough was laminated and extruded to form a dumpling wrapper with 65 mm diameter and 2 mm thick. Dumpling wrappers were stored at -20°C for a week and thawed at room temperature before analyzing. Stuffing recipe preparation was based on the methods of Yanqi et al. (Yanqi et al., 2008). Dumplings with the same amount of stuffing recipe were made by a manual dumpling device.

2.3. Color measurement

Color interferes with flavor perception of people and may considerably affect the acceptability of foods. The color measurement was carried out on the surface of dumpling wrapper using a colorimeter (ADCI 60, Chen Taike, Beijing, China). Before testing, the colorimeter was calibrated with a black and a white plate. The dumpling wrapper was overlapped with three layers and both side was measured, the analysis was performed in triplicate for each samples. Results were expressed as L (lightness), a (redness) and b (yellowness).

2.4. DSC

A DSC Q10 calorimeter (Mettler-Toledo, Switzerland) with an empty pan as reference was used to determine the amount of freezable water in dumpling wrapper. Samples (dumpling wrappers prepared in Section 2.2) were removed from the center of the dumpling wrapper, exactly weighed (~ 10 mg) into an aluminum pan and hermetically sealed immediately before analysis. The samples were cooled to -50°C at a rate of $5^\circ\text{C}/\text{min}$ with liquid nitrogen, held for 5 min at -50°C , and then heated to 20°C at $5^\circ\text{C}/\text{min}$ under

nitrogen gas. Frozen water content (FWC) was calculated by the following Eq. (1) (Lodi and Vodovotz, 2008). Total water was determined by dehydration at 105°C with a vacuum drying oven.

2.5. Water holding capacity (WHC)

Water holding capacity (WHC) was measured according to the method of Onofre with some modification (Onofre and Wang, 2010). 1 g of substituted wheat flour was homogeneously mixed and added to a pre-weighed 50 mL polypropylene centrifuge tube containing 30 mL of deionized water. The tube was placed in a water bath at 30°C for 1 h, followed by cooling in ice bath. The tube was then centrifuged for 10 min at $8000 \times g$ using a centrifuge (TG16-WS, Xiangying, Hunan, China). The supernatant was disregarded and the tube with the precipitate was weighed. The WHC was calculated using the following Eq. (2):

2.6. NMR transverse relaxation (T_2) measurement

The molecular mobility of different dumpling wrappers was analyzed by T_2 assays with Mini MR-60 (Niumag Corporation of Shanghai, China). Operating at 23.2 MHz by Carr-Purcell-Meiboom-Gill (CPMG) sequence. Samples were analyzed in triplicate at $32 \pm 0.1^\circ\text{C}$. Approximately 30 g of samples (dumpling wrappers prepared in Section 2.2) were placed into a NMR tube and then sealed with parafilm to avoid moisture loss during the experiment.

Proton relaxation is normal in exponential form, and relaxation time constant can be determined from the decay curves. For heterogeneous systems like dough, a multicomponent model is used (Eq. (3)) (Raun et al., 1999). The NMR relaxation decay curves were fitted into this model with inversion software.

2.7. Scanning electron microscopy (SEM)

The microstructures of dumpling wrapper samples (control and APS-12.5) were observed by a scanning electron microscope (Quanta 200, FEI) with 20 kV acceleration voltage. The dumpling wrappers were cut into 1 cm^2 size and frozen at -80°C , the frozen dumpling wrappers were then freeze-dried with a vacuum freeze drier. The interior surface of all the samples was exposed to gold sputtering before photographed.

2.8. Statistical analysis

All experiments were conducted at least twice. Data were analyzed by SPSS statistical software (Version 20.0, SPSS Inc., Chicago, IL, USA), the one-way-analysis of variance (ANOVA) followed by least significant difference test (LSD) and Duncan was used ($p < 0.05$). Results were showed as means and standard deviations (SD). SPSS was used to verify significant differences amongst dumpling samples produced at the same storage time.

3. Results and discussion

3.1. Farinograph

Farinograph properties of APS substituted wheat flours were showed in Table 1. There was no significant change in water absorption between control and wheat flour contain with APS. APS-10, APS-12.5 and APS-15 had significantly shorter development time than control. One of the model for dough development is the continuity of the protein network depends on non-covalent crosslinks such as hydrogen bonds and hydrophobic interactions (Lee et al., 2001). For APS, the steric hindrance of ester group led to lots of hydroxyl group exposed to others. The increasing of hydrogen bond resulted in the increasing of protein network, which indicated that

Download English Version:

<https://daneshyari.com/en/article/4513307>

Download Persian Version:

<https://daneshyari.com/article/4513307>

[Daneshyari.com](https://daneshyari.com)