FOOD PACKAGING AND SHELF LIFE 3 (2015) 88–96

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/fpsl

Quality attributes of minced pork wrapped with catechin–lysozyme incorporated gelatin film

Pimonpan Kaewprachu [a], Kazufumi Osako [b], Soottawat Benjakul [c], Saroat Rawdkuen [a,*]

[a] Food Technology Program, School of Agro-Industry, Mae Fah Luang University, Muang, Chiang Rai 57100, Thailand
[b] Department of Food Science and Technology, Tokyo University of Marine Science and Technology, Tokyo 108-8477, Japan
[c] Department of Food Technology, Faculty of Agro-Industry, Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand

ARTICLE INFO

Article history:
Received 5 May 2014
Received in revised form
13 October 2014
Accepted 25 November 2014
Available online 20 January 2015

Keywords:
Catechin
Gelatin film
Lysozyme
Minced pork
Polyvinyl chloride

ABSTRACT

The objective of this study was to monitor and compare the quality of minced pork when wrapped with catechin–lysozyme incorporated gelatin film (CLGF) and commercial film (polyvinyl chloride; PVC) during refrigerated storage (7 days at 4 °C). The PVC showed greater mechanical properties [TS: 59.55 MPa and EAB: 241.94 (%)] than the CLGF but less thickness [0.0103 mm], water vapor permeability [2.61×10^{-6} g mm h^{-1} cm^{-2} Pa^{-1}], and film solubility [1.78%]. The physical, chemical and microbiological qualities of minced pork wrapped with CLGF or PVC were compared. Changes in the qualities of minced pork were determined throughout the storage. It was found that sample wrapped with CLGF showed less weight loss (1.20–2.92%), less decoloration (CLGF–PVC; L^* = 50.04–53.86, a^* = 4.60–3.13, b^* = 7.30–11.17), and decreased TBARS (1.29–1.57 mg malonaldehyde/kg sample) compared to that wrapped in the PVC. Microbial growth rates in the sample wrapped with the CLGF (total plate count 4.15 log CFU/g; yeast and mold 2.99 log CFU/g) were lower than those observed in the PVC film. Successful inhibition of lipid oxidation and microbial growth in the refrigerated minced pork was possible with CLGF. The catechin–lysozyme incorporated gelatin film could maintain the quality of minced pork and thus prolong its shelf-life.

1. Introduction

The quality and appearance of minced pork on supermarket shelves are very important for consumers. The spoilage and un-marketability of minced pork or other meat products are mainly caused by chemical and microbiological deteriorations. Spoilage of fresh pork by microorganism occurs mostly due to improper handling before and after it is slaughtered. This spoilage mostly happens by contamination and deterioration which once identified, calls for necessary changes in how the meat is handled including thermal/non-thermal processing as well as applying food preservatives. The spoilage of pork by chemical reaction is normally caused by protein degradation as well as the oxidation reaction of lipid. These causes depend on the raw material composition, technique of processing and handling, and storage condition of raw material (Saghir, Wagner, & Elmadfa, 2005). Abnormal

* Corresponding author. Tel.: +66 53 916752; fax: +66 53 916739.
E-mail address: saroat@mfu.ac.th (S. Rawdkuen).
http://dx.doi.org/10.1016/j.fpsl.2014.11.002
2214-2894/

appearances as well as strong off-flavor are the quality attributes of minced pork that make unaccepting by the consumer. Phenomenon that affect the appearance of pork such as purge or drip loss (liquid secreted out of the minced pork) and discoloration, typically occur during atmospheric storage (Antoniewski, Barringer, Knipe, & Zerby, 2007). Lipid oxidation also resulted in off-flavor development is most often associated with consumer unacceptable (Gennadios, Hanna, & Kurth, 1997).

One technology that may possibly be used for extending the storage life of minced pork is active packaging. This kind of packaging provides several functions that conventional packaging systems do not such as oxygen scavenging, moisture or ethylene preserving, ethanol and flavor emissions prevention, and inhibitory activity to microbial growth (Thiansilakul, Benjakul, & Richards, 2011). The incorporation of antimicrobial and antioxidant agents in flexible films is emerging as a promise technology, as the majority of solid or semi-solid foods present high microbial growth in their surface and lipid oxidation. Active packaging systems that incorporate natural antimicrobials or antioxidative substances provide safety, control undesirable changes to food, and prolong shelf-life (Suppakul, Miltz, Sonneveld, & Bigger, 2003). Active compounds that are normally used as antimicrobials or provided for antioxidant activities include acetic acid, chitosan, catechin, gallic acid, lysozyme or nisin (Rawdkuen, Suthiluk, Kamhangwong, & Benjakul, 2012a).

One of the most investigated for antimicrobial enzyme as natural antimicrobial agents in packaging applications is lysozyme. Food and Drug Administration and the European Union approved lysozyme as GRAS and as a food additive, respectively (Mendes de Souza, Fernández, López-Carballo, Gavara, & Hernández-Muñoz, 2010). Lysozyme is a single polypeptide chain that can split the bonds of the peptidoglycan in the cell wall of bacteria (Coma, 2008). Catechin (epicatechin, epicatechin gallate, epigallocatechin gallate and epogallocatechin) is one type of flavanol that shown strong antioxidant activity. It contains large amount of aromatic rings with hydroxyl groups (Rodríguez Vaquero, Alberto, & Manca de Nadra, 2007; Schamberger & Labuza, 2007).

Biodegradable films can be prepared from different types and sources of proteins, polysaccharides or can be formed by blending with some type of lipids. Gelatin is one of the most widely investigated protein-based films. It is derived from collagen by using partial hydrolysis reaction. Gelatin has been widely applied as a starting material for biodegradable film formation (Rawdkuen, Sai-Ut, & Benjakul, 2010; Rawdkuen, Suthiluk, Kamhangwong, & Benjakul, 2012b). It can be used to produce a thin film with good properties both in terms of physical and barrier to gas and water transmission properties (Cha & Chinnan, 2004). Its general intended use is as a film and coating for meat products. Results show that when coated with this film, it can reduce the drip loss of different types of muscle food products such as beef, pork, fish as well as poultry meats (Antoniewski et al., 2007). The additions of catechin–lysozyme to act as the active ingredients to retard lipid oxidation and inhibit microbial growth also have been investigated (Rawdkuen et al., 2012b). However, the properties of the film have not yet been compared to commercial wrap film, especially in terms of the mechanical properties and applicability. The purpose of this investigation was to apply the gelatin film blended with catechin–lysozyme to minced pork and compare it with commercial wrap film in the shelf-life extension.

2. Materials and methods

2.1. *Materials*

Catechin hydrate (C1251) and lysozyme from chicken egg white (62971) was purchased from Sigma–Aldrich (St. Louis, MO, USA). Trichloroacetic acid (TCA), thiobarbituric acid (TBA), 1,1,3,3-tetramethoxypropane, and glycerol were obtained from Merck (Darmstadt, Germany). Microbial transglutaminase (MTGase) (Activa TG-AK: 50–84 units/g) was purchased from Ajitrade (Thailand) Co. Ltd. (Bangkok, Thailand). Plate Count Agar, Potato Dextrose Agar, and de Man, Rogosa and Sharpe (MRS) Agar were obtained from the Biological Laboratories, Mae Fah Luang University. Export 160/20 edible gelatin (bovine hide) was obtained from Gelita NZ Limited (Woolston Christchurch, New Zealand). Minced pork was purchased from Makro hypermarket in Chiang Rai, Thailand (Date of manufacture: 03/09/2012 Lot no. 19).

2.2. *Preparation of gelatin-based film*

Film-forming solution (FFS; 3 g/100 g protein) was prepared by mixing the gelatin powder with distilled water. Fifty grams per 100 grams of glycerol (based on protein content) in FFS was used as a plasticizer. The mixture was incubated at 60 °C for 30 min in a shaking water bath. When the FFS was cooled, the CLC (catechin and lysozyme combination with a ratio of 1:1) at 0.5 g/100 g and microbial transglutaminase (MTGase) (0.07 g/100 ml FFS) were added (Rawdkuen et al., 2012b). De-aerated FFS (4 g) was cast onto a rimmed silicone resin plate (50 mm $\times$ 50 mm) and then evaporated for 24 h before dried with a ventilated oven environmental chamber at 25 $\pm$ 0.5 °C and 50 $\pm$ 5% relative humidity (RH) for another 24 h. The final dried gelatin-based films were manually peeled.

2.3. *Film properties determinations*

Both the CLGF and the commercial PVC films were used as the starting material for determining their properties as follows.

2.3.1. *Film thickness*

The film thickness (9 random locations around each film samples) was measured with a hand-held micrometer (Bial Pipe Gauge, Peacock Co., Tokyo, Japan).

2.3.2. *Mechanical properties*

The tensile strength (TS) and elongation at break (EAB) of the films were determined by using a Universal Testing Machine (Lloyd Instrument, Hampshire, UK). Ten samples (2 cm $\times$ 5 cm) with an initial grip length of 3 cm were used with the condition of testing of the cross-head speed at 30 mm/min with 100 N load cell.