Microbial Characteristics and Lipid Oxidation of Thawed Pork Loin Wrapped with Gelatin Based Films with Natural Food Antimicrobial Compounds

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Abstract— **The aim of this study was to determine antimicrobial and antioxidation effect of the gelatin based edible film with natural extracts exhibiting antimicrobial capacity in meat packaging. Thawed pork loin was stored in the refrigerator without film (Con), film with 7% gelatin film (T1), 1% Golden thread (T2), 4% egg white (T3), and 2% lysozyme (T4). Gelatin film with egg white and lysozyme showed significantly low TBARS values at storage day 1. Films containing 1% Golden thread significantly reduced total microbes by 1.6 Log CFU/g at storage day 1 and 5 compare to that of control and 7% gelatin film. Coliforms of T3 were not detected at all at day 1 and were significantly reduced on day 10 and 15. No *E.coli* was detected in all treatments. This result indicated that gelatin based film with Golden thread and lysozyme could enhance shelf-life of pork loin and could be used as film material in industry.**

Keywords— **Edible film, antimicrobial activity, pork loin.**

I. INTRODUCTION

Recently there is an increasing interest in edible packaging, due to factors such as environmental pollution, the need for new storage techniques and the possibility of generating new markets for products originated from newable natural sources, such as biopolymers (Durango et al., 2006; Guilbert et al., 1996). Edible coatings and films have been applied to processed foods to retard and prevent movement of water and gases. Although commercially available synthetic polymers, such as polyethylene and polypropylene, effectively control gas permeability (GP) and water vapor permeability (WVP), concerns over their non-renewable nature generates interest in more environmentally friendly, renewable biopolymers (Arvanitoyannis, 2002). Edible films may be prepared from biopolymers such as polysaccharides, proteins and lipids that present advantages such as biodegradability, edibility, aesthetic appearance and good barrier properties against oxygen (Durango et al., 2006).

Collagen is an abundant protein constituent of connective tissue in vertebrate (about 50% of total human protein) and invertebrate animals (Jhonston-Banks, 1990). Thermal or chemical dissociation of collagen polypeptide chains forms products known as gelatine. The primary structure of gelatine is almost identical to that of parent collagen but for some small differences due to the pretreatment and extraction processes. These differences include removal of amide groups of asparagines and glutamine, conversion of arginin to ornithine, and (partial) removal of telopetides (Johnston-Banks, 1990).

Thin gelatine films are rich in colloid material and behave similar to rigid gels exhibiting elastic moduli and time-dependent phenomena (Arvanitoyannis, 2002). Tensile strength and elongation are equally important physical properties for edible film applications. The mail parameters affecting film-forming properties of gelatine are raw material source, extraction method, molecular weight, film preparation method (hot or cold casting), and degree of hydration or presence of plasticizer (Arvanitoyannis, 2002). The major disadvantage of gelatine as a food packaging materials is its poor mechanical properties. So, segmental orientation induced by hot and cold and rapid zone drawing, and cross-linking were used to improve mechanical properties of gelatine films (Fakirov et al., 1996).

The objective of this study was to develop an antimicrobial film based on gelatine containing natural antimicrobial compounds such as Golden thread, egg white, and lysozyme and to evaluate its a potential to increase the shelf-life of thawed pork loin.

II. MATERIALS AND METHODS

Materials

Gelatine was purchased from local company. Hwang-Ryun was obtained from herb medicine market and extracted with ethanol and lyophilized. Lysozyme was obtained from Sigma Co. All chemicals used were of analytical grade. Thawed pork loin was used to identify effect of antimicrobial edible films on shelf-life of meat.

Preparation of gelatine edible films

Gelatine filmogenic solutions were prepared under the following conditions: 7% gelatine, 1.5% plasticiser. The filmogenic solutions were applied to plexiglass plates (12*12cm). The solutions were dehydrated in an drying oven of the ambient relative humidity (55-65 %) at 30℃ for 24 hrs .

Edible film characterization

For film analysis, the films were conditioned for 48hrs at 25℃ and 50% relative humidity in chambers. The film thickness was measured using a digital micrometer (Mitutoyo Co., Tokyo, Japan).

Mechanical properties

Tensile strength (TS) and elongation at break (E) were measured by a rheometer with 10 replicates.

Water vapour permeability (WVP)

WVP of films was determined at 25℃ of relative humidity 55 % according to the ASTM E96 method.

Film gas permeability

Gas permeability of film was measured by method of ASTM D 3985 using oxygen transmission rate tester (Mocon Inc., OX-TRAN 2/21) in four replications.

TBARS measurement

TBARS of pork loin packaged with edible film was determined by methods of Witte et al. (1970).

Microbial characteristics

Total microbes, *E.coli*, and coliform of thawed pork loin were measured for 15 days.

Statistical Analysis

An analysis of variance was performed using the General Linear Model (GLM) procedure of the SAS statistical package (SAS, 2001). Duncan's multiple range test ($p<0.05$) was used to determine significant differences among means.

III. RESULTS AND DISCUSSION

Mechanical Characteristics of films

Tensile strength (TS) and elongation of Gelatine films with Golden thread, egg white, and lysozyme were measured (Table 1). Gelatine film containing Golden thread showed lowest TS. However, elongation capacity was higher than other treatments. Film thickness of gelatine only was 47um and showed lowest value. Gelatine with egg white showed higher thickness as 82um. WVP and oxygen permeability of gelatine films with Golden thread were lower than other films.

Shelf-life of pork with edible film

TBARS of pork loin with gelatine film containing egg white and lysozyme was significantly lower than other treatments on storage day 1 (Table 2). However, gelatine film with lysozyme significantly reduced TBARS values during whole storage days. In total microbes of pork loin during storage, gelatine film with Golden thread significantly reduced number of microbes on day 1 (Table 3). However no difference was found between gelatine only film and gelatine film with Golden thread, egg white, and lysozyme on day 5, 10, 15, respectively. This may due to high numbers of microbes at initial experiment.

Table 1 Tensile strength and elongation of gelatine film with natural antimicrobial compounds

Day	Tensile strength (MPa)	Elongation (%)	Thickness (mm)	WVP (gmm/m^2hkPa)	Oxygen permeability (cc/m^2day)
1	90.17±7.88a	11.38±1.50b	0.047±0.001c	0.67±0.019b	1.33±0.001a
5	53.62±6.19b	22.43±3.34a	0.053±0.001b	0.42±0.002d	0.618±0.001c
10	84.08±15.83a	23.16±0.97c	0.082±0.001a	0.91±0.004a	1.328±0.001a
15	90.88±11.69a	2.83±0.667c	0.053±0.002b	0.56±0.008c	0.996±0.001b

Table 2 TBARS values (mg MA/kg) of pork loin packed with gelatine based edible film

Day	Con	GEL	HRN	EGG	LYS
1	0.14±0.055^{Ab}	0.14±0.010^{Ac}	0.12±0.006^{ABc}	0.11±0.010^{Bc}	0.09±0.004^{Bc}
5	0.14±0.071^{Ab}	0.13±0.006^{Ac}	0.12±0.025^{Ac}	0.12±0.030^{Ac}	0.09±0.004^{Ac}
10	0.20±0.015^{BCb}	0.24±0.049^{Ab}	0.15±0.008^{Db}	0.22±0.054^{ABb}	0.18±0.018^{CDb}
15	0.33±0.045^{Ba}	0.30±0.038^{BCa}	0.28±0.011^{BCa}	0.39±0.086^{Aa}	0.25±0.019^{Ca}

Table 3 Microbial characteristics of pork loin packed with gelatine based edible film

	Day	Con	GEL	HRN	EGG	LYS
TPC	1	5.52±0.157^{Ac}	4.46±0.189^{Bb}	4.04±0.357^{Cb}	5.77±0.173^{Ab}	4.69±0.141^{Bc}
	5	6.16±0.639^{Abc}	4.70±0.100^{Bb}	4.55±0.303^{Bc}	5.95±0.346^{Ab}	5.01±0.317^{Bc}
	10	6.64±0.205^{Bb}	6.72±0.090^{Ba}	6.24±0.137^{Bb}	7.33±0.533^{Aa}	6.30±0.352^{Bb}
	15	7.66±0.457^{Aa}	6.91±0.191^{Ba}	7.21±0.225^{ABa}	7.70±0.174^{Aa}	7.35±0.309^{BAa}
Coli Form	1	2.17±0.237^{Ac}	0.60±0.521^{Bb}	1.12±0.248^{Bb}	2.03±0.019^{Ab}	1.10±0.348^{Bb}
	5	2.93±0.082^{Ab}	1.27±1.099^{Bb}	1.53±1.379^{ABb}	2.30±0.357^{ABb}	1.90±0.000^{ABb}
	10	3.34±0.230^{Aab}	3.53±0.128^{Aa}	2.14±1.850^{Aa}	3.64±0.231^{Aa}	2.40±2.111^{Aa}
	15	3.79±0.413^{Aa}	3.74±0.102^{Aa}	2.38±2.066^{Aa}	3.68±0.231^{Aa}	2.34±2.024^{Aa}
E.coli	1	-	-	-	-	-
	5	-	-	-	-	-
	10	-	-	-	-	-
	15	-	-	-	-	-

TPC: Total plate counts

IV. CONCLUSIONS

The results indicated that Golden thread and lysozyme can be used as antimicrobial materials in edible film and useful to enhance the shelf-life of pork loin.

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