HIGH HYDROSTATIC PRESSURE TO IMPROVE HYGIENIC QUALITY OF COMMERCIAL DUCK MEAT PRODUCTS

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Abstract – The objective of this study was to investigate the microbial contamination of commercial duck meat products in Korea, and the effect of high hydrostatic pressure (HHP) on improvement of hygienic quality. HHP treatment was applied at 0.1, 300, 400, and 500 MPa and microbial analysis was carried out. The levels of total aerobic bacteria were in the ranges of 3.53-6.19 and 3.62-6.85 log CFU/g in raw and smoked duck meat products, respectively. HHP treatment significantly reduced the levels of microorganisms in raw and smoked duck products. The HHP treatment at 500 MPa reduced the number of aerobic bacteria in duck meats to undetectable levels. This study demonstrates that HHP treatment can be used to effectively improve the hygienic quality of commercial raw and smoked duck meat products.

Key Words – Commercial duck meat products, High pressure, Microbial contamination.

I. INTRODUCTION

Duck meat can be a good source of protein for humans [1] and is high in iron, selenium, and niacin, as well as fewer calories than the other meat [2]. The consumption of duck meat and duck meat products was increased approximately 5 folds in Korea from 1997 to 2012 [3]. With increase of duck meat consumption, there must be consideration of hygienic quality and safety of duck meat products available in the market due to the outbreaks associated with duck meat and meat products [2].

High hydrostatic pressure (HHP) processing is a non-destructive and chemical-free food preservation technology that efficiently eliminates food spoilage microorganisms. The ability of HHP to eradicate microorganisms regardless of product geometry and without preservatives/additives [4] makes this technology safe and consumer-friendly [5].

Therefore, the current study was designed with the objectives of evaluating microbial contamination in raw and smoked duck meat products that are commercially available in Korea, and for determining the efficiency of HHP on microbial reduction.

II. MATERIALS AND METHODS

Sample preparation

Raw [sliced (A, B, C, G, H), bone-in whole (D, E, F, J), and deboned (I)] and smoked [sliced (K, L, M, N, O, P) and deboned (Q, R, S)] duck meat products were collected from local market (Seoul, Korea). Raw products A-F were stored at 4°C while G-J were at -20°C. All smoked products were kept at 4°C before purchase. The samples were transferred to the laboratory and approximately 5 g of each sample was obtained, vacuum-packaged (-650 mmHg in 10 × 10 cm low-density polyethylene/nylon vacuum bags with oxygen permeability of 22.5 mL/m^2/24 h atm at 60% RH/25°C and water vapor permeability of 4.7 g/m^2/ 24 h at 100% RH/25°C), sealed, and stored at refrigerated condition (4°C) before HHP treatment.

High hydrostatic pressure treatment

The vacuum-packaged samples were transported to the Korea Food Research Institute (Seongnam, Korea) in a cooled container and immediately subjected to HHP. Samples were placed in a pressure vessel submerged in hydrostatic fluid (Quintus food processor 6; ABB Autoclave Systems, Inc., Columbus, OH, USA) and pressurized at 300, 400 and 500 MPa for 5 min with the initial temperature of the pressure

vessel set at 15±3°C. Control samples were maintained under atmospheric pressure at 4°C while the other samples were treated. Immediately after treatment, all samples were transported to the laboratory in iced condition.

Microbial analysis

Each sample was homogenized for 2 min with a 45 mL of sterile saline solution using the Stomacher BagMixer® 400 (Interscience Co., St Nom, France). Then samples were serially diluted in sterile saline (0.85%) solution, and each diluent (0.1 mL) was spread on plate count agar (Difco Laboratories, Detroit, MI, USA). Plates were incubated at 37°C for 48 h and microbial counts were expressed as colony forming units per gram (CFU/g).

Statistical analysis

Each set of data represents the mean of three different replications with three observations. Mean values and the standard deviation were calculated using a SAS software and one-way analysis of variance (ANOVA) was performed. When significant differences were detected, the differences among the mean values were determined by performing the Duncan's multiple comparison test at a confidence level of $p<0.05$.

III. RESULTS AND DISCUSSION

The total aerobic bacterial populations in commercial raw duck meats ranged from 3.53 to 6.19 log CFU/g (Table 1). For refrigerated samples, bone-in whole raw duck meat showed significantly lower total aerobic bacterial counts than those in sliced raw duck meats. Samples stored frozen did not consistently show differences by product type. Levels of aerobic bacteria in smoked duck products ranged from 3.62 to 6.85 log CFU/g (Table 2). Samples did not consistently show differences by product type.

Several studies have been carried out to assess the contamination levels of duck meat products in Korea. It was reported that the numbers of total aerobic bacteria were 4.30, 3.43, and 3.84 log CFU/g for fresh, fresh-torched, and frozen-thawed types of duck breast meats, respectively [6]. The initial microbial load of meat depends on the physiological status of the duck at slaughter, contamination at slaughterhouses, and contamination during processing. The temperature and storage conditions during distribution also influence the rate of spoilage [7].

Table 1. Microbial population (log CFU/g) of the raw duck meat products with different temperature commercially available in Korea

Temperature (°C)	Type	Products	Total aerobic bacteria
4	Sliced	A	4.56±0.17[1)]
		B	5.33±0.25
		C	5.75±0.12
	Bone-in whole	D	4.40±0.26
		E	3.68±0.10
		F	3.53±0.24
-20	Sliced	G	4.12±0.09
		H	6.19±0.05
	Deboned	I	5.39±0.03
	Bone-in whole	J	4.97±0.04

[1)]Mean ± standard deviation.

Table 2. Microbial population (log CFU/g) of the refrigerated (4°C) smoked duck meat products commercially available in Korea

Type	Products	Total aerobic bacteria
Sliced	K	6.41±0.33[1)]
	L	6.85±0.01
	M	4.90±0.04
	N	6.50±0.34
	O	5.61±0.09
	P	4.55±0.18
Bone-in whole	Q	3.62±0.29
	R	6.84±0.03
	S	5.33±0.24

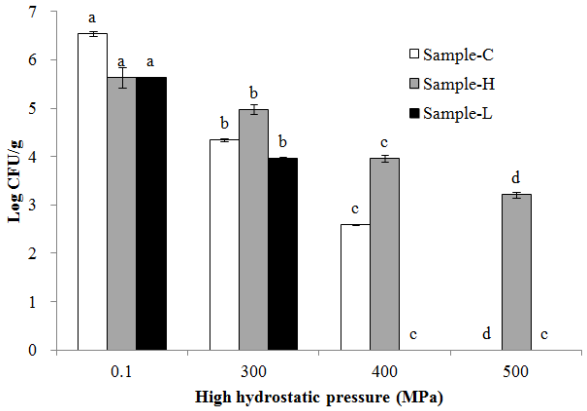
[1)]Mean ± standard deviation.

HHP was evaluated for the ability to control microbial populations of selected duck meat products (C, H, and L) that had the largest microbial. HHP treatment reduced the numbers of total aerobic bacteria in raw and smoked duck meat products significantly (Fig. 1). The HHP at 500 MPa reduced the level of total aerobic bacteria to undetectable levels (<1 log CFU/g), except for in raw sample H.

Microbial cellular membranes are affected by HHP, resulting in osmotic changes, lysis, alterations of nuclear material, and other modifications, which can result in cell death [8]. Pressures between 100 and 400 MPa efficiently reduced the numbers of bacteria of strains of *Salmonella* spp. [9]. Additionally, it was indicated that pressures of 450 to 600 MPa almost completely eliminated three major pathogens, i.e.,

Salmonella Typhimurium, *Escherichia coli*, and *Listeria monocytogenes* [10, 11].

Figure 1. Effect of high hydrostatic pressure processing on the number of total aerobic bacteria (log CFU/g) of duck meat



[a-d]Different superscripts within the same level of high hydrostatic pressure treatment differ significantly ($p<0.05$)

IV. CONCLUSION

The hygienic quality of commercial raw and smoked duck meat products in Korea need to be improved. HHP treatment, at 300-500 MPa, significantly improved hygienic quality of the duck meat products.

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