EFFECT OF CHILLING WATER TEMPERATURE ON DUCK BREAST

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Background and objective:

Duck is a waterfowl and has a different physiology to that of other poultry. Although duck is very popular in many region of the world, duck processing does not get enough attention by the researcher. Duck breast meat composed of 70 to 90 % oxidative red fibers (Type IIA) (Baeza, 1995), where as chicken breast meat is almost Type IIB (white) (Smith and Flether, 1992). Muscle types vary in their potential to cold shorten during chilling. Honikel et al. (1981) reported that when beef muscle was exposed to temperature above 25ºC, or below 4ºC, greater muscle shortening occurred and was directly related to greater amounts of muscle drip loss. Joo et al. (1999) also found that color and water-holding capacity of pork were affected by muscle temperature during slaughtering and storage due to denaturation of sarcoplasmic proteins. Limited research was published with Type IIA muscle type compare to Type IIB and Type I. Therefore, the present study was undertaken to find out the effect of chilling water temperature on muscle strip of duck breast meat for investigating the toughness and meat quality parameters.

Materials and methodology:

Eight ducks (Chungdong ori, age 48 days, *Anas platyrhynchos*) were slaughtered and breast meat was collected with in 10 min of slaughter. Each breast meat was divided into 2 muscle strips (2×6 cm) and 4 muscle strips from each duck were numbered. The muscle strip from 8 ducks (32 in number) were equally divided according to number for each position of breast meat into 4 groups and incubated in water at 0ºC, 10 ºC, 20 ºC and 30 ºC for 60 min in a insulating box. Just after chilling the strips were analyzed for drip loss, water-holding capacity, cooking loss, shear force, color (CIE* L*, a*, b*), sarcomere length, protein solubility and SDS-page electrophoresis.

Results and discussion:

Results from Table 1 indicated that drip loss (%), cooking loss (%) and shear force (kg/cm^2) were lowest, while water holding capacity (%) and sarcomere length (μm) were highest at 10 ºC chilling water. Results from sarcomere length (μm) indicated that muscle shortening were happened at 0 ºC, 20 ºC and 30 ºC temperature and most severe at 30 ºC. Honikel et al. (1986) found in excised red bovine muscle (M. sternomandibularis) sarcomeres contracted up to 70% below 6 ºC and 40% between 20 ºC and 38 ºC, while in red porcine M. cleidooccipitalis the minimum shortening was measured at about 10 ºC, a higher degree of shortening up to 50% being obtained above or below this temperature and found a positive relationship with drip loss. Our results also agreed with the previous findings, as highest sarcomere length (lower muscle shortening) and lowest drip loss found at 10 ºC. Again, Dunn et al. (1993) found maximum shortening 39% and 43% occurred at 0 ºC and 40 ºC respectively in chicken breast muscle. They also found that most shortening occurred within 90 min postmortem at 0ºC and at 40 ºC, most shortening occurred during the development of rigor mortis between 90 and 380 min of postmortem.

In our experiment, lightness (L*) did not show any significant differences, while redness (a*) and yellowness (b*) showed lowest value at 0 ºC. Reasons for these changes in color with different chilling methods are unclear. However, Gigiel et al. (1989) studied various chilling systems operating at different temperatures and fail to note any effects on meat color or water holding capacity in pork. Myofibrillar, sarcoplasmic and total protein solubility also did not showed significantly different in muscle strip incubated at different temperatures. Jones et al. (1993) reported that blast-chilling did not decrease protein denaturation. No differences in major protein bands were found from SDS-page gel electrophoresis (Figure 1) at 4 different temperature levels, which indicates that chilling does not affect major protein denaturation within 0 ºC to 30 ºC. However, in our experiment, no significant differences in protein solubility between 4 treatments of chilling have a relation with SDS-page electrophoresis. Therefore, SDS-page electrophoresis did not show any changes in major protein bands.

Conclusions:

It was found that cold shortening was happened at 0 ºC, while hot shortening found at 20 ºC and 30 ºC in duck breast meat. The shortening was severe at 30 ºC with higher drip loss, cooking loss, and shear force value with lower water holding capacity. The shortening was lower at 10 ºC compare to other chilling water temperature with lower drip loss, cooking loss and shear force value with higher water holding capacity. Therefore, may be recommended that during processing duck carcass should be chilled at 10 ºC water after slaughter.

Table 1. Drip loss (%), cooking loss (%), water holding capacity (%), shear force (kg/cm^2) and sarcomere length (μm) of muscle strip of duck breast treated with different chilling water temperature

Temperature	Drip loss	Cooking loss	WHC	Shear Force	Sarcomere Length
0 ºC	2.17±0.40^{AB}	37.97±1.11^{A}	47.79±5.59^{AB}	3.78±0.06^{AB}	1.41±0.04^{B}
10 ºC	1.28±0.21^{B}	33.64±1.50^{B}	51.25±4.38^{A}	3.63±0.08^{B}	1.58±0.04^{A}
20 ºC	1.98±0.55^{AB}	36.44±1.32^{A}	49.34±4.44^{A}	3.65±0.08^{B}	1.43±0.03^{B}
30 ºC	2.80±0.29^{A}	38.53±1.74^{A}	44.02±4.10^{B}	3.86±0.05^{A}	1.24±0.03^{C}

$^{A-B}$Means with different superscripts within a column differ significantly ($p<0.05$); WHC=Water holding capacity.

Table 2. CIE* color value and protein solubility of muscle strip of duck breast treated with different chilling water temperature

Incubation temperature	CIE* color value			Protein solubility		
	L*	a*	b*	Myofibrillar	Sarcoplasmic	Total
0 ºC	47.23±0.79	14.51±0.51^{B}	5.38±0.75^{B}	120.92±2.55	81.58±1.90	202.50±1.43
10 ºC	47.67±0.51	16.08±0.55^{A}	6.92±0.70^{A}	117.55±7.22	79.00±2.75	196.55±7.22
20 ºC	46.22±0.88	15.61±0.37^{AB}	7.55±0.42^{A}	116.99±6.84	79.41±2.12	196.40±6.11
30 ºC	45.98±0.76	16.28±0.37^{A}	7.62±0.62^{A}	125.39±11.51	80.07±2.05	205.45±9.89

$^{A-B}$Means with different superscripts within a column differ significantly ($p<0.05$).

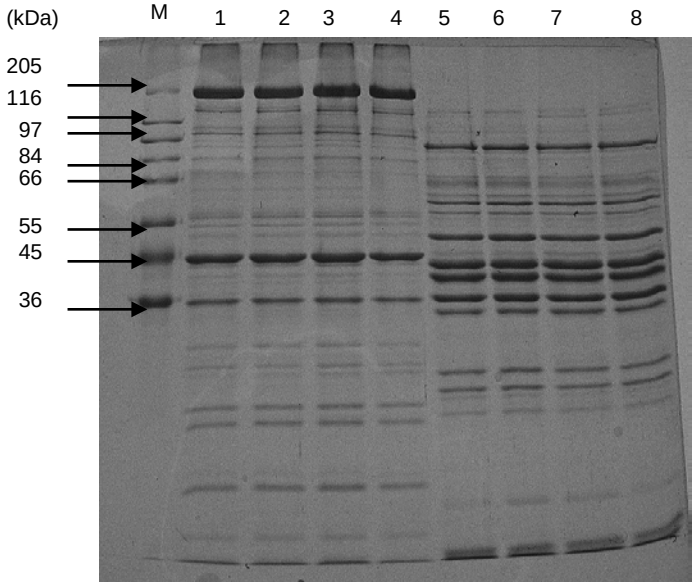

Figure 1. SDS-page pattern of myofibrillar (1-4) and sarcoplasmic (5-8) protein of duck breast muscle strip incubated at different chilling temperature water (where, 1& 5=0ºC, 2 & 6=10 ºC, 3 & 7=20 ºC and 4 & 8=30 ºC) chilling for whole duck carcasses. M denote protein molecular mass standards.

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