Effects of muscle fibre type on meat characteristics of chicken and duck breast muscle

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Abstract

Fifteen broilers and fifteen ducklings were stunned and killed to evaluate muscle fibre type and meat characteristics. The chicken breast contained 100% type IIB muscle fibre, while duck breast contained 73.3% type IIB and 26.7% type IIA muscle fibre. Duck breast had significantly higher fat content, while chicken breast had higher protein content. Redness, cooking loss and TBARS value were significantly higher in duck breast compared to chicken breast. Chicken breast showed rapid pH decline at post-mortem, whereas duck breast showed rapid increase of TBARS values during cold storage. Duck breast had significantly higher C14:0, C16:0, C16:1, C18:2 and C18:3 while chicken breast had higher C18:0 and C 20:4. Results suggest that the higher redness, fat content, cooking loss and rapid lipid oxidation of duck breast may be due to its higher contents of muscle fibre type IIA and unsaturated fatty acids compare to chicken breast.

Introduction

Duck has a different physiology compare with chicken or other poultry. Duck is very popular and in strong demand in Asia, especially in Korea. However, duck meat has received little attention by the researchers compare to other poultry meats. More recently duck cuts, such as breast and leg have become more available, which offer more options for diet conscious consumers in Korea. In general, slaughter procedure of duck is followed like chicken in spite of duck has more red muscle fibres compare to chicken and consider as red meat. Therefore, it needs to be followed different slaughtering, processing and preservation method for better quality of duck meat. The objective of this study was to investigate composition of muscle fibre type, pH decline pattern at post-mortem, meat characteristics and fatty acid composition of duck and chicken breast.

Materials and methods

Fifteen broilers (Ross) and fifteen ducklings (Chungdong ori, *Anas platyrhynchos*) aged at 48 days were stunned and killed by conventional neck cut. Breast meats (*Pectoralis major*) were removed from each carcass at the following times post-mortem: 15 min (3 birds from each species), 30 min (3 birds from each species), and 1 h (complete processing rest of the birds). The breast meat were then placed in plastic bag and kept in a cold storage room at 4 ºC.

The pH was measured by a pH-meter (MP230, Mettler, Switzerland). The surface color (CIE L* and a*) of meat samples was measured using a Minolta Chromameter (Minolta CR 301, Tokyo, Japan). Shear force was measured by using the Instron Universal Testing Machine (Model 3343) from each cooked breast meat samples. For fatty acid analysis, lipids were extracted with chloroform and methanol and fatty acid methyl esters were analyzed on a gas chromatography (Agilent, 6890, USA).

The distribution of muscle fibre types was measured with the serial frozen sections (8 ㎛ thick) stained by histochemical reactions. Myosin adenosine triphosphatase activities were detected after acid (pH 4.3) and alkaline (pH 10.5) pre-incubation (Brooke and Kaiser, 1969). All histochemical samples were examined by an image analysis system (Image-Pro Plus, Media Cybernetics, USA). Approximately 100 fibres per sample were evaluated, and Fig. 1 showed the representative pictures of muscle fibres of duck and chicken breast. Fibre number percentage was obtained from the ratio of the number of each fibre type to the total number of fibre counted

Results and discussion

Muscle fibres of duck breast contained 73.3% type IIB and 26.7% type IIA, whereas chicken breast contained 100 % type IIB muscle fibre only (Fig. 1).

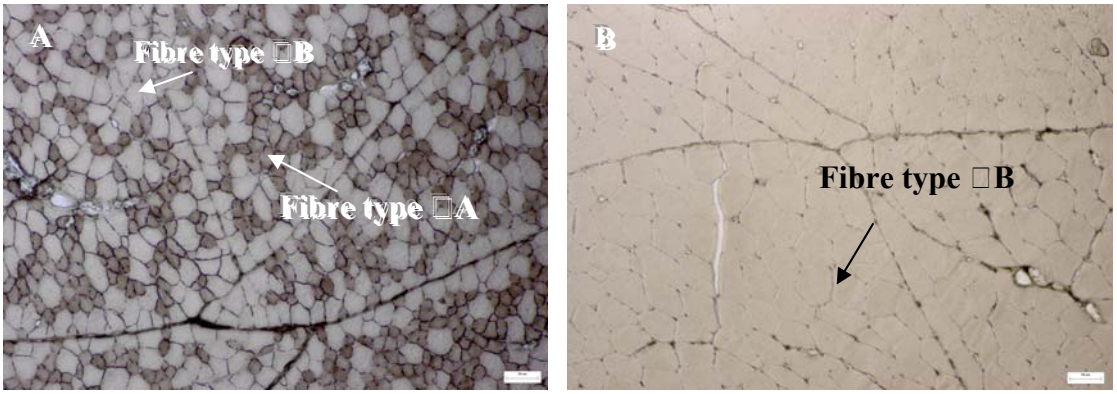

Figure 1. Histochemical ATPase staining of duck(A) and chicken(B) breast muscle. Magnification of 100 × was used (Bar = 50 μm).

Smith et al. (1993) found 16% and 100 % white fibres in *Pectoralis* muscle of duck and chicken, respectively. Protein content was significantly higher in chicken breast whereas fat content was higher in duck breast (Table 1). Significant differences in muscle pH were found at 1 and 3 h post-mortem between two species (Fig. 2). The pH of chicken meat was significantly lower than duck meat at 1 and 3 h post-mortem, but the ultimate pH at 24 h was not different. These results suggest that the rapid pH decline and lower fat content of chicken breast may be due to its higher content of muscle fibre type IIB compare to duck breast.

Table 1. The proximate composition (%), meat color(L*, a*), cooking loss(%) and shear force(kg/cm^2) in chicken and duck breast meat

Meats	Proximate composition				Color		Cooking loss	[1]Shear force
	Moisture	Protein	Fat	Ash	L*	a*		
Chicken	75.5	22.0^X	1.1^Y	1.1^X	57.1^X	1.7^Y	29.2^Y	3.5
Duck	76.4	20.1^Y	1.8^X	0.9^Y	39.7^Y	18.2^X	34.5^X	3.8

^{X,Y}Means with different superscripts within same column differ significantly ($p<0.05$).

Because duck breast had higher content of muscle fibre type IIA, as expected, significantly higher redness (a*) and lower lightness (L*) values were observed in duck breast compared to chicken breast (Table 1). Also cooking loss of duck breast was significantly higher than that of chicken breast. However, there was no significant difference in shear force between two species. Alvarado and Sams (2000) also found higher cooking loss and shear force value in duck breast compare to chicken breast at different post-mortem time. These results suggest that the higher redness and cooking loss of duck breast may be due to its higher content of muscle fibre type IIA compare to chicken breast.

Duck breast showed rapid increase in TBARS values compare to chicken breast during cold storage (Fig. 2). The TBARS values of duck breast were significantly higher than those of chicken breast for 7 days of cold storage. Moreover, the fatty acids (%) C14:0, C16:0, C16:1, C18:2 and C18:3 were significantly higher while C18:0 was significantly lower in duck breast compared to chicken (Table 2). Significant changes in fatty acids composition were found in both chicken and duck breast meat at 1 and 7 days of cold storage, and the changing was severe in duck breast compared to chicken breast. These results suggest that rapid lipid oxidation of duck breast compare to chicken breast may be due to its higher content of unsaturated fatty acids and severe changes in fatty acid composition during cold storage. Data also suggest that duck should be slaughtered and processed with different way from chicken for a desirable meat quality.

Table 2. Fatty acid composition (%) of chicken and duck breast meat

Fatty acid	Chicken breast		Duck breast	
	1 day	7 days	1 day	7 days
C14:0	0.4^{BY}	0.8^{A}	0.9^{AX}	0.4^{B}
C16:0	17.2^{BY}	22.5^{A}	21.8^{X}	22.0
C 16:1	2.2^{Y}	3.3	4.2^{AX}	2.1^{B}
C 18:0	18.2^{AX}	10.5^{B}	10.5^{AY}	14.5^{B}
C 18:1	34.3	36.7	35.7	31.5
C 18:2	14.2^{BY}	16.7^{A}	19.3^{AX}	15.1^{B}
C 18:3	0.5^{Y}	0.6	0.8^{AX}	0.5^{B}
C 20:4	11.2	7.1	5.5^{B}	12.1^{A}
C22:5	0.9	0.9	0.7	0.8
C22:6	1.0	0.9	0.6	0.9
SFA	35.8	33.9	33.2^{B}	36.9^{A}
USFA	64.2	66.1	66.8^{A}	63.1^{B}

[A-B]Means with different superscripts in a row within chicken breast or duck breast differ significantly ($p<0.05$).
[X-Y]Means with different superscripts in a row within 1 day chicken and duck breast differ significantly ($p<0.05$).

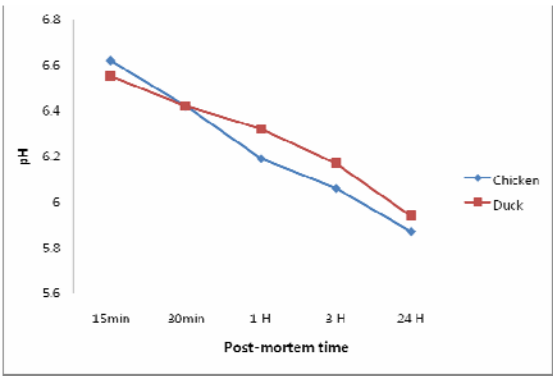

Figure 2. The pH decline pattern of chicken and duck breast meat.

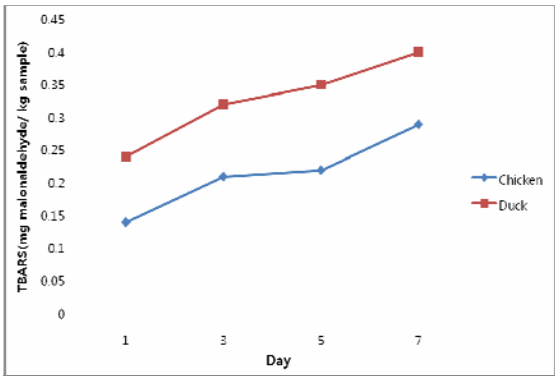

Figure 3. Changes in TBARS value of chicken and duck breast meat during cold storage.

Conclusions

Duck had higher muscle fibre type IIA compared to chicken, resulted in different proximate composition, pH decline pattern at post-mortem and meat characteristics. The higher TBARS values and severe changes in fatty acid composition were observed in duck breast compared to chicken breast during 7 days of cold storage. These results suggest that duck should be slaughtered, processed and preserved with different way from chicken for better quality of duck meat.

References

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