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A Comparison of Meat Characteristics between Duck and Chicken Breast

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ABSTRACT : Twenty four broilers (Ross) and 24 ducklings (Cherry berry) aged 45days were stunned and killed by conventional neck cut to evaluate the meat characteristics and fatty acid composition of breast meat. Breast meats were removed from each carcass at different post-mortem times. After complete processing, the breast meats were then placed in a polythene bag and kept in a cold storage room at 4°C for 7 days. The pH of meat samples at different post-mortem times, and meat characteristics and fatty composition at different storage times were evaluated. No significant differences were found in pH at different post-mortem times except at 30 min postmortem, where duck breast showed significantly lower pH than chicken breast. As expected, duck breast meat had significantly higher redness (a*), but lower lightness (L*) value compared to chicken breast. During whole storage time, the a* value remained constant in duck breast. Cooking loss (%) was higher in duck breast compared to chicken breast during the whole storage time. Shear force decreased with increasing storage time in both chicken and duck breast meat, moreover, it decreased rapidly in duck breast compared to chicken breast. The TBARS values increased with increasing storage time in both duck breast and chicken breast meat and was significantly higher in duck breast. 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. SFA was increased, while USFA and MUSFA decreased only in duck breast during the 7 day storage time. (**Key Words :** Chicken Breast Meat, Duck Breast Meat, Poultry Meat Characteristics)

INTRODUCTION

Duck is a waterfowl and has a different physiology to that of other poultry. Duck is still very popular and in strong demand in many area of the world, especially in Asia. However, duck meat has received little attention by researchers compared to other poultry. More recently duck cuts, such as breast and legs, have become more available which offer more options for diet-conscious consumers. Continuing modification in genetic variety of poultry species in recent years has created a need for updating existing data on muscle quality. In particular, it is necessary to determine the changes in physical and chemical characteristics of muscles and of their constituents in different strains or crosses; as such characteristics can influence the quality of processed meat products (Richardson and Jones, 1987). Duck meat production is based mainly on commercial crossbreeds of different Pekin (*Anas platyrynchos*) strains (Pingel, 1997; Zeidler, 1998).

Storage method and time are two of the most important factors in meat physical characteristics. In beef, the L*, a* and b* values increase dependent on the storage time (Feldhusen et al., 1995; Insausti et al., 1999). Tenderness decreases with storage time in beef (Morgan et al., 1991). Application of low temperature, both refrigeration and freezing, allows extension of the self life of many foods for long periods by slowing the rate of chemical reactions and inhibiting microbial growth. Regarding long-term freezing, both lipid and protein fractions of muscle foods have been reported to undergo chemical and/or structural changes which result in flavor and texture modifications (Sikorskia, 1978).

Normally, slaughtering procedure for duck is similar to chicken. Duck has higher red muscle fiber in breast compared to chicken (Smith et al., 1993) and is considered as red meat. Therefore, a different slaughtering, processing and preservation method needs to be followed for duck. The objective of this study was to compare declining pattern for pH at different post-mortem times, and also meat characteristics and fatty acid composition of duck and broiler breast during storage.

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MATERIALS AND METHODO

Twenty four broilers (Ross broiler) and 24 ducklings (Cherry berry) aged 45 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 of remaining birds). The breast meat was then placed in a polythene bag (22 cm×18 cm) and kept in a cold storage room at 4°C. The 12 birds of each species (3 at each experimental post-mortem time) were used to analyse the pH. The remaining 12 birds were used to determine color, fatty acid (1 and 7 days only), TBARS, cooking loss and shear force value at different storage times. Proximate analysis was measured on the birds used for pH determination at 24 h post-mortem.

Proximate composition

Three samples from each meat type were analyzed for moisture, protein, fat and ash by the standard procedures of AOAC (1995).

pH

The pH of meat samples was measured using a pH-meter (MP230, Mettler, Switzerland) that was calibrated daily with standard pH buffers of 4.0 and 7.0 at 25°C.

Color analysis

The surface color (CIE L*, a*) of chicken and duck breast was measured using a Minolta Chromameter (Minolta CR 301, Tokyo, Japan). Three random readings were taken from each meat type.

Fatty acid analysis

Lipids were extracted with chloroform and methanol as described by Folch et al. (1957). The extracts were concentrated using an evaporator (Zymark turbovap 500, Hopkinton, MA, USA) at 40°C under nitrogen and stored at -40°C until required for analysis. For lipid hydrolysis, an aliquot of lipid extract (30 mg) and 3 ml of 4% H_2SO_4 in methanol were combined in a screw-capped test tube. The test tube was placed in boiling water (100°C) for 20 min and subsequently cooled at room temperature. The resulting free fatty acids were methylated with 1 ml of 14% boron trifluoride in methanol at room temperature for 30 min and then water (1 ml) and hexane (5 ml) were added. Samples were vortexed and centrifuged at 500×g for 10 min. The upper organic solvent layer was used to determine fatty acid composition. Fatty acid methyl esters were analyzed on a gas chromatograph (Agilent, 6890, USA) equipped with an on-column injector port and flame-ionization detector. A fused silica capillary column (60 m×0.32 mm×0.25 μm; Supelco, Bellefonte, PA, USA) was used for the separation of the fatty acid methyl esters. The gas chromatograph oven temperature was 140°C, and increased at a rate of 2°C/min to a final temperature of 230°C. The injector port and detector temperatures were set at 240°C and 250°C, respectively. Fatty acid methyl ester (1 ml) was injected onto the split injection port (100:1 split ratio). The flow rate for helium carrier gas was 50 ml/min. Each fatty acid was detected by reference to retention time of the standards.

TBARS analysis

Meat sample (5 g) was weighed into a 50-ml test tube and homogenized with 15 ml of deionized distilled water using the Polytron homogenizer (IKA Labortechnik T25-B, Selangor, Malaysia) for 10s at the highest speed. Meat homogenate (1 ml) was transferred to a disposable test tube (3×100 mm), and butylated hydroxyanisole (50 μl, 10%) and thiobarbituric acid/trichloroacetic acid (TBA/TCA, 2 ml) were added. The mixture was vortexed and then incubated in a boiling water bath for 15 min to develop color. The sample was cooled in cold water for 10 min, vortexed again, and centrifuged for 15 min at 2,000×g. The absorbance of the resulting supernatant solution was determined at 531 nm against a blank containing 1 ml of double distilled water (DDW) and 2 ml of TBA/TCA solution. The amounts of TBARS were expressed as milligrams of malondialdehyde per kilogram of meat.

Cooking loss

Breast meat samples were broiled to an internal temperature of 90°C for 30 min, surface dried, and weighed. Cooking loss was determined by expressing cooked sample (B) weight as a percentage of precooked sample (A) weight following the procedure of Yang et al. (2006).

$$\text{Cooking loss (\%)} = [(A-B)/(A)]\times 100$$

Shear force

Shear force was measured using the Instron Universal Testing Machine (Model 3343). From each cooked breast meat sample, as close as practicable to a 0.5×4.0 cm (approximately 2.0 cm^2) cross section was cut for shear force measurements. The meat samples were placed at right angles to the blade. Crosshead speed was 100 mm/min and full scale load was 50 kg.

Statistical analysis

The data in this experiment were analyzed by the analysis of variance procedure of Statistical Analysis Systems Institute (SAS) and a Duncan's procedure was used to determine the significant differences between means at a 5% level of significance (SAS, 1997).

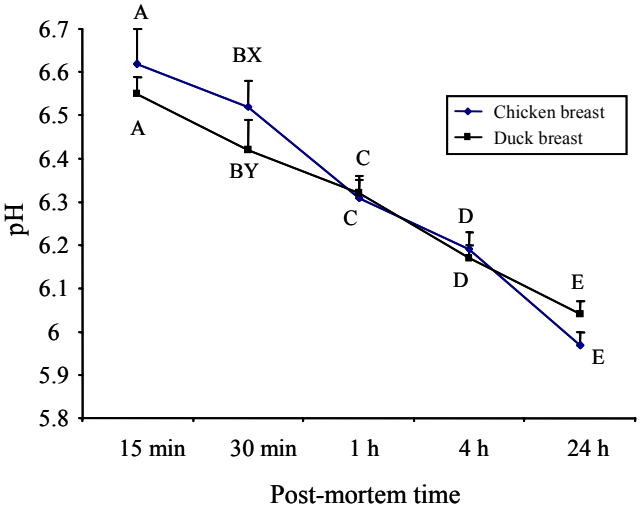

Figure 1. The declining pH pattern in chicken and duck breast meat at different post-mortem time. A-E: values with different letter within each meat type differ significantly ($p<0.05$); X-Y: values with different letter at same post-mortem time differ significantly ($p<0.05$).

RESULTS AND DISCUSSION

No significant differences ($p>0.05$) were found in pH between the two species at the same post-mortem time except at 30 min (Figure 1). The pH of chicken meat was significantly higher than duck meat at 30 min post-mortem ($p<0.05$). This difference indicates that the rate, or pattern, of pH decline immediately after post-mortem is different between the two species but the final pH values after 24 h are similar. Smith and Fletcher (1992) found a different pH of chicken and duck breast muscle at 30 min, 1 h and 4 h post-mortem, although the ultimate pH at 24 h was similar. Again, differences in pH were also found in the same muscle of different strains within the same species. The pH at 15 min, 1 h and 24 h varied significantly among breast meat of 4 broiler lines (Berri et al., 2001). Mazanowski et al. (2003) stated that the average pH at 24 h post-mortem was 6.0 and 6.4 in meat from A44 and A55 strains of ducks.

Proximate composition and other meat characteristics of chicken and duck meat are presented in Table 1. No significant differences were found in moisture content between breast meats of the two species ($p>0.05$). Significant ($p<0.05$) differences were found in crude protein, fat and total ash content between the breast meat samples from the two species. Crude protein and ash content were significantly higher in chicken breast, while fat content was significantly higher in duck breast ($p<0.05$). Smith et al. (1993) stated that duckling breast meat contained significantly more moisture and lipid, but lower protein, ash and calories than chicken breast meat. Although, no significant differences ($p>0.05$) in moisture content were found between chicken and duck breast, the value was higher in duck breast in this study. However, the higher fat and lower protein content of duck breast in our experiment agreed with former results. Mazanowski et al. (2003) found the fat content in duck breast meat was 1.7% in their experiment which was similar to our results.

As expected, duck breast meat contained significantly higher redness (a*), but lower lightness (L*) value compared to chicken breast (Table 2). The higher a* value in duck breast meat compared to chicken breast should be related to higher red muscle fibers in duck breast compared to chicken, as Smith et al. (1993) stated that duckling breast muscle contained approximately 16% white fibers and 84% red fibers compared with 100% white fibers in chicken breast. During whole storage time, the a* value remained constant in duck breast, while it was the lowest at 7 days storage time in chicken breast. The yellowness (b*) was not significantly different between chicken and duck breast at 1

Table 1. The proximate composition (%) of chicken and duck breast meat

Source of meat	Proximate composition (%)			
	Moisture	Protein	Fat	Ash
Chicken breast	75.47±1.44	22.04±0.48^{X}	1.05±0.30^{Y}	1.07±0.04^{X}
Duck breast	76.41±0.70	20.06±0.52^{Y}	1.84±0.08^{X}	0.92±0.11^{Y}

$^{X-Y}$ Mean±SD values with different superscripts within same column differ significantly ($p<0.05$).

Table 2. The color (CIE L*, a*, b*) values of chicken and duck breast meat during cold storage

Color of different meat samples		Storage days			
		1	3	5	7
L*	Chicken breast	57.06±5.41^{AX}	54.07±4.15^{BX}	53.48±3.40^{BX}	57.04±3.51^{AX}
	Duck breast	39.66±1.15^{BY}	41.84±1.90^{ABY}	41.74±2.40^{ABY}	43.24±2.08^{AY}
a*	Chicken breast	1.70±0.99^{ABY}	2.45±0.96^{AY}	2.04±1.27^{ABY}	1.25±0.83^{BY}
	Duck breast	18.16±1.19^{AX}	19.12±0.58^{AX}	18.77±1.45^{AX}	19.01±1.48^{AX}
b*	Chicken breast	5.17±2.83^{B}	8.43±1.66^{AX}	7.77±2.85^{AX}	6.03±1.53^{B}
	Duck breast	4.91±0.87^{B}	5.35±1.50^{ABY}	5.71±1.64^{ABY}	6.57±1.24^{A}

$^{A-C}$ Means with different superscripts within a row differ significantly ($p<0.05$); $^{X-Y}$ Means with different superscripts within a column with same parameter differ significantly ($p<0.05$).

Table 3. The cooking loss (%) and shear force (kg/cm^2) characteristics of chicken and duck breast meat during cold storage

Storage time (days)	Cooking loss (%)		Shear force (kg/cm^2)	
	Chicken	Duck	Chicken	Duck
1	29.19±0.93^{AY}	34.48±1.48^{X}	3.47±0.33^{AY}	3.84±0.31^{AX}
3	27.21±2.66^{ABY}	35.45±1.82^{X}	3.26±0.47^{A}	3.36±0.29^{B}
5	24.84±3.40^{BCY}	35.61±0.83^{X}	3.41±0.34^{A}	3.44±0.37^{B}
7	22.20±1.84^{CY}	35.56±0.57^{X}	2.66±0.37^{BY}	3.12±0.21^{CX}

$^{A-C}$ Mean±SD values with different superscripts within same column differ significantly ($p<0.05$).
$^{X-Y}$ Mean±SD values with different superscripts within a row with same parameter differ significantly ($p<0.05$).

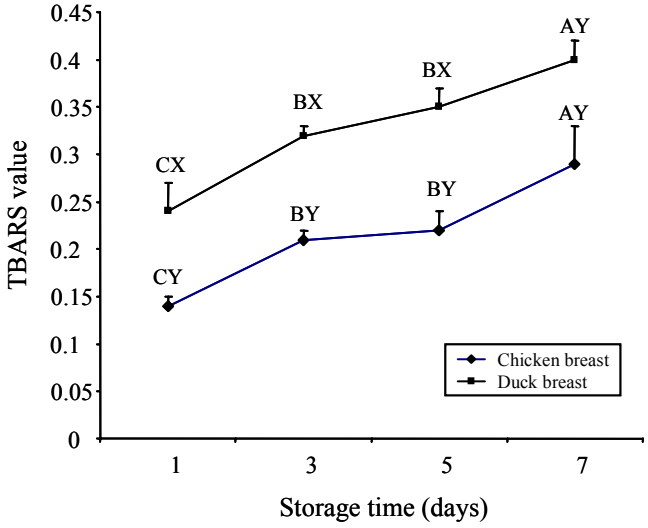

Figure 2. The TBARS values (mg malonaldehyde/ kg sample) of chicken and duck breast meat at different storage time. A-C: values with different letter within each meat type differ significantly ($p<0.05$). X-Y; values with different letter at same storage time differ significantly ($p<0.05$).

Table 4. Fatty acid composition of chicken and duck meat

Fatty acid	Chicken breast		Duck breast	
	1 day	7 days	1 day	7 days
C14:0	0.36^{BY}	0.78^{A}	0.91^{AX}	0.38^{B}
C16:0	17.22^{BY}	22.53^{A}	21.83^{X}	22.01
C 16:1	2.17^{Y}	3.27	4.16^{AX}	2.14^{B}
C 18:0	18.17^{AX}	10.54^{B}	10.46^{AY}	14.48^{B}
C 18:1	34.32	36.67	35.66	31.48
C 18:2	14.15^{BY}	16.74^{A}	19.34^{AX}	15.14^{B}
C 18:3	0.53^{Y}	0.60	0.84^{AX}	0.52^{B}
C 20:4	11.23	7.06	5.49^{B}	12.12^{A}
C22:5	0.89	0.94	0.68	0.83
C22:6	0.96	0.88	0.61	0.91
SFA	35.75	33.85	33.21^{B}	36.86^{A}
USFA	64.25	66.15	66.79^{A}	63.14^{B}
MUSFA	36.49	39.93	39.82^{A}	33.62^{B}
PUSFA	27.75	26.22	26.97	29.51
MUSFA/SFA	1.03	1.18	1.20^{A}	0.91^{B}
PUSFA/SFA	0.77	0.77	0.81	0.80

$^{A-B}$ 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 ($p<0.05$).

and 7 days storage time, while the b* value was significantly higher ($p<0.05$) at 3 and 5 days storage time in chicken breast than duck breast.

Cooking loss (%) was higher in duck breast compared to chicken breast during the whole storage time (Table 3). Shear force (kg/cm^2) was higher in duck breast compared to chicken during the whole storage time with a significantly higher value at day 1 and 7. Moreover, shear force decreased with increasing storage time in both chicken and duck breast meat, and it decreased rapidly in duck breast compared to chicken breast. Smith and Fletcher (1992) observed higher Allo-Kramer shear values in duckling breast than chicken breast when compared at 0 and 24 h aging periods. Alvarado and Sams (2000) also found higher cooking loss and shear force value in duck breast compared to chicken breast at different post-mortem deboning times. Higher cooking loss in duck meat despite a higher proportion of oxidative fiber may be related to water holding capacity of duck and chicken meat. Joseph et al. (1972) stated that duck muscles have comparatively lower water holding capacity than chicken muscles, resulting in greater cooking loss and less emulsion stability. Biswas et al. (2006) also found lower cooking yield and emulsion activity in duck meat patties compared to broiler and spent hen meat patties, as better stability of emulsion is related to better retention of water and fat in the meat matrix.

In our experiment, although significant differences were found in shear force value between the breast meat of the two species at 1 and 7 days, the values were also higher in duck breast compared to chicken at 3 and 5 days storage time ($p>0.05$). However, the decreased shear force value with increasing storage time related to the tenderness of meat, as tenderness decreases with storage time in beef (Morgan et al., 1991).

The TBARS values (mg malonaldehyde/kg sample) increased with increasing storage time in both duck breast and chicken breast meat (Figure 2). The TBRAS values were significantly higher in duck breast compared to chicken breast over the whole storage time. It is normally accepted that with increasing storage time TBARS value increases in meat, although the pattern of increased TBARS value in different species is not yet well known. The oxidative status of breast meat evaluated as TBARS level

was different in different genetic strains and a higher TBARS value was found with increasing storage time in broilers (Castellini et al., 2006). Russell et al. (2003) also found a higher TBARS value in duck breast meat with increasing storage time. Pettersen et al. (2004) found that TBARS value increased up to 6 months in turkey breast meat and then started to decline.

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 4). Significant changes were found in chicken and duck breast meat after 1 and 7 days storage time in some fatty acid composition. The total SFA, USFA and MUSFA showed significant differences only in duck breast between 1 and 7 days storage time. SFA was increased, while USFA and MUSFA decreased in duck breast during 7 days storage time. These results indicated that change in fatty acids was severe in duck breast compared to chicken breast meat samples during storage.

CONCLUSIONS

The significant difference in pH decline at 30 min post-mortem indicates differences in glycolytic metabolism in duck breast meat compared to chicken. Also the higher TBARS value in duck meat indicates higher oxidative metabolism in the duck. From the findings in this study, it was suggested that the higher value in redness of duck breast meat would be associated with differences in meat characteristics compared to chicken breast meat. Further research, under strictly controlled conditions, is necessary to help explain the relationship between composition of muscle fiber types and meat quality in chicken and duck breast.

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REFERENCES

Alvarado, C. Z. and A. R. Sams. 2000. The influence of post-mortem electrical stimulation on rigor mortis development, calpastatin activity, and tenderness in broiler and duck pectoralis. Poult. Sci. 79:1364-1368.

AOAC. 1995. Officials methods of analysis, 16th Editions. Association of Official Analytical Chemist, Washington, DC.

Berri, C., N. Wacrenier, N. Millet and E. Le Bihan-Duval. 2001. Effect of selection for improved body composition on muscle and meat characteristics of broilers from experimental and commercial lines. Poult. Sci. 80:833-838.

Biswas, S., A. Chakraborty and S. Sarkar. 2006. Comparison among the qualities of patties prepared from chicken broiler, spent hen and duck meats. J. Poult. Sci. 43:180-186.

Castellini, C., A. D. Bosco, C. Mugnai and M. Pedrazzoli. 2006. Comparison of two chicken genotypes organically reared: oxidative stability and other qualitative traits of the meat. Italian J. Anim. Sci. 5:29-42.

Feldhusen, F., A. Warnatz, R. Erdmann and S. Wenzel. 1995. Influence of storage time on parameters of colour stability on Beef. Meat Sci. 40:235-243.

Folch, J., M. Lees and G. H. Sloane-Stanley. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Bio. Chem. 226:497-507.

Insausti, K., M. J. Beriain, A. Purroy, P. Alberti, L. Lizaso and B. Hernandez. 1999. Color stability of beef from different Spanish native cattle breeds stored under vacuum and modified atmosphere. Meat Sci. 53:241-249.

Joseph, J. K., O. O. Balogun and M. A. Famuyiwa. 1992. Carcass evaluation and organoleptic assessment of some selected Nigerian birds. Bulletin of Animal Health and Production in Africa, 40:97-102.

Mazanowski, A., T. Kisiel and E. Gornowicz. 2003. Carcass quality, meat traits and chemical composition of meat in ducks of paternal strains A44 and A55. Animal Science Papers and Reports, Institute of Genetics and Animal Breeding, Poland, 21:251-263.

Morgan, J. B., J. W. Savell, D. S. Hale, R. K. Miller, D. B. Griffin, H. R. Cross and S. D. Shackelford. 1991. National Beef Tenderness Survey. J. Anim. Sci. 69:3274.

Pettersen, M. K., M. B. Mielnik, T. Eie, G. Skrede and A. Nilsson. 2004. Lipid oxidation in frozen, mechanically deboned turkey meat as affected by packaging and storage conditions. Poult. Sci. 83:1240-1248.

Pingel, H. 1997. Perspective of the production of waterfowl. In: 11th European Symp. On Waterfowl, Nantes, France, 128-134.

Richardson, R. I. and J. M. Jones. 1987. The effects of salt concentration and pH upon water-binding, water-holding and protein extractability of turkey meat. Intl. J. Food Sci. Technol. 22:683-692.

Russell, E. A., A. Lynch, K. Galvin, P. B. Lynch and J. P. Kerry. 2003. Quality of raw, frozen and cooked duck meat as affected by dietary fat and α-tocopheryl acetate supplementation. Intl. J. Poult. Sci. 2:324-334.

SAS. 1997. SAS Software for PC. SAS Institude Inc., Cary, NC, USA.

Sikorskia, Z. E. 1978. Protein changes in muscle foods due to freezing and frozen storage. International Journal of Refrigeration, 1:173-180.

Smith, D. P. and D. L. Fletcher. 1992. Post-mortem biochemistry of Pekin ducklings and broiler chicken pectoralis muscle. Poult. Sci. 71:1768-1772.

Smith, D. P., D. L. Fletcher, R. J. Buhr and R. S. Beyer. 1993. Pekin ducklings and broiler chicken pectoralis muscle structure and composition. Poult. Sci. 72:202-208.

Yang, H. S., S. S. Moon, J. Y. Jeong, S. G. Choi, S. T. Joo and G. B. Park. 2006. Effect of sodium bicarbonate injection in pre-rigor porcine *M. Longissimus lumborum* on pork quality. Asia-Aust. J Anim. Sci. 19:898-904.

Zeidler, G. 1998. Poultry products in the 21 st century. In: Proc. 10th Europ. Poultry Conf., Jerusalem, Israel, 1:132-141.