# ULTRASTRUCTURAL CHANGES OF DUCK MEAT DURING AGING

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***Abstract*—This study was carried to ultrastructural changes of duck breast meat during aging. Generally, eating quality of post-mortemed meat is very tough and hard. It is believed that aging may improve meat tenderness, so that appropriate aging is very important. Forty-five old peckin ducks were used as duck meat samples and after slaughter, carcasses were refrigerated at 0℃ and 4℃ for examination with transmission electron microscopy during 7days. As aging progressed, myofibrils damage increased and Z-line, I-band, A-band and M-line were damaged compare to earlier stage. Myofibrils collapsed with substantial cut in Z-line but also with M-line cuts in all parts of myofibrils. After 5 days, histological changes during aging process at 4℃, shows that mitochondria and other organisms were fill in the gaps between myofibrils. Sarcomere length was influenced by temperature.**

***Index Terms*— Aging, Duck, TEM, Temperature, Ultrasture,**

## I. INTRODUCTION

**Meat tenderness is one of the impotant meat quality characteristics for consumer selection(Gerelt, Ikeuchi, Nishiumi and Suzuki, 2001; Warkup, Marie, and Harrington, 1995). Generally meat aging may improve meat tenderness and its taste. Therefore, appropriate aging is important. Changes of myofibrillar structure is the weakening and breakdown with the consequent transversal fragmentation during aging(Prates, Garcia, Ribeiro, and Dias, 2002). Meat aging is a truly complex process dependended on many factors, such as animal spices and muscle fibre type. In postmortem muscle, disintegration of the Z-line is one of major structural changes. Suzuki, Matsumoto, Sato, and Nonami(1982) reported that the breakdown could be related to removal of a Z-line protein. Long time ago, several studies suggested that Z-line degradation is the main factor contributing to meat tenderisation, which is the basis of the "Z-disk theory"(Hattori and Takahashi, 1979; Robson, 1995).**

**There have been reports on ultrastructural researches about beef (Boyer-Berri and Greaser, 1998; Maher, Mullen and Mononey, 2005; Choi, Kim, and Lee, 1995), chicken (Yoon, 2003; Ahn and Park, 1998), rabbit (Sotelo, Perez-Munuera, Quiles, Hernando, Larrea and Lluch, 2004; Mestre et al., 2002) and reindeer (Taylor, Labas, Smulders and Wiklund, 2002) *etc*. However, there were a few ultramicrostructure papers of duck meat. Duck meat is also poultry meat but its breast meat is red muscle unlike chicken meat's white muscle Thus, duck meat may have different characteristics from chicken meat's ultrastructure. The purpose of this study was carried to ultrastructural changes of duck breast meat during storage at 0℃ and 4℃.**

## II. MATERIALS AND METHODS

### Sample preparation

**Used ducks samples were 45 days old Peckin spices. After slaughter, carcasses were refrigerated at 0℃ for 7 days and 4℃ for 5days. Breast lean meats were separated from carcasses for ultrastructural changes analysis.**

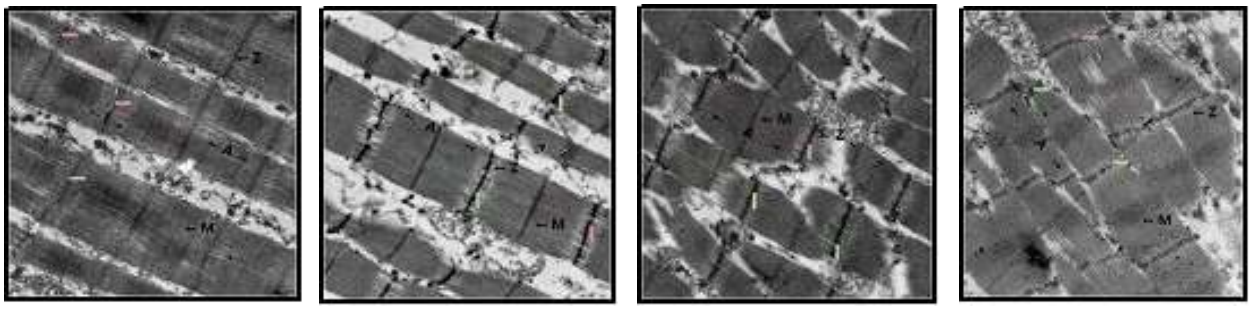
### Transmission electron microscopy(TEM) analysis

**The muscle samples were processed by transmission electron microscopy analysis according to conventional procedures. Briefly, The samples were cut into cubes (1×3×5mm), fixed with 5% glutaraldehyde(first fixative) and with 1% osmium tetroxide (secondary fixative) at 4℃. Muscle fragments were dehydrated with ethanol and propylene oxide and embedded in an epon-mixture and propylene oxide (1:1) for overnight. Then, samples were buried under epoxy resin embedding media and polymerized for hardening sample tissues at 35℃, 45℃, 60℃ and 70℃. Thin sections(60-90nm) of embedded tissues were cut using ultra microtome(LEICA ULTRACUT 90nm, Swiss) and stained with uranyl acetate and lead citrate. Ultrastructural changes in myofibrils were**

observed and were captured by transmission electron microscopy(Carl Zeiss LEO-912AB, German). Magnification of TEM was 15,750 X.

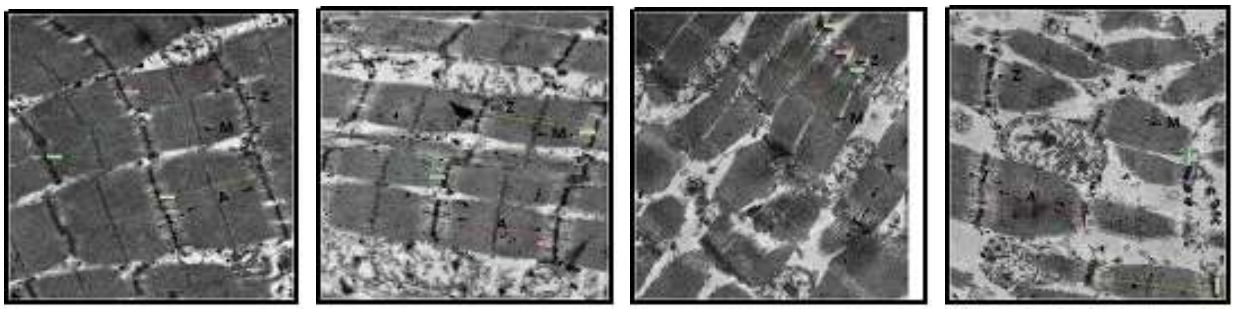
## III. RESULTS AND DISCUSSION

Ultrastructural_Histological changes of duck breast meat using TEM are shown in figure. Fig. 1 shows histological changes during aging at 0℃. Breast meat 0 day after slaughter illustrates as (a) showing sarcomeres arranged evenly. Two days after the aging shows the results of sarcomeres which are streatched and partially damaged (b). Also Z-line, I-band, A-band and M-line are clearly seen. Figure (c) shows 5 days after aging when myofibrils are more damaged compare to earlier stage. Myofibrils collapsed with substantial cut in Z-line but also with M-line cuts in some parts of myofibrils. Gerelt et al. (2002) reported that beef with $CaCl_2$ treatment's M-line and I band boundaries were blurred compare to the control and 168 hours after, Z-line and I-band have been seriously damaged. Choi et al. (1995) found out the myofibril structural change and partial Z-line loss of beef with different packaging and aging temperatures.



(a) (b) (c) (d)

**Figures 1. Histological changes of the breast meat during aging at 0℃ with 15,750 X of TEM magnification. M-line, Z-line, A-band and Sarcomeres length show. (a) : 0 day, (b) : 2 day, (c) : 5 day, (d): 7 day**



(e) (f) (g) (h)

**Figures 2. Histological changes of the breast meat during aging at 4℃ with 15,750 X of TEM magnification. M-line, Z-line, A-band and Sarcomeres length show. (e) : 1 day, (f) : 2 day, (g) : 3 day, (h) : 5 day**

Figure 2 shows histological changes during aging process at 4℃. Figure(e) of 1 day after slaughter shows Z-line, I-band, A-band and M-line clearly, though myofibrillars arrangements were not evenly spread over. Figure(f) shows that I-band has been stretched significantly and the spaces between myofibrils have widened. This indicates myofibrills being partially damaged. Figure (g) shows that myofibrils are clearly damaged. During aging process at 4℃, most myofibrils cuts were made from Z-line, some from M-line. Figure (h) shows mitochondria and other organisms filling in gaps between myofibrils. Boyer and Greaser (1998) found that beef aging at 4℃ reduced Z-line but there was increase in I-band. Sotelo et al. (2003) reported that rabbitt's *semimembranosus* muscle with *petridium aquilinum* found in histological change, parts of perimysial, endomysial and connective tissue were damaged after 72 hours at 4℃. That is After 24 hours, sarcolemma reduced and gaps were widened. After 32 hours, tissue fiber collapsed. After 72 hours, muscle bundles were reduced and intercellular gaps were widened.

**Sarcomere length change(Table 1) was from 1,326±5.3 nm after slaughter immediately but as aging progressed, the length has increased to 2,062.2±34.6 nm at maximum after 3 days of aging at 0℃. After 7 days, the length has decreased to 1,792.5±35.1 nm. One day after the aging at 4℃, sarcomere length was 1,732.1±43.9 nm. Five days later, the length has decreased down to 1,921.2±80.2nm. This result was similar to the result from 0℃ aging. Yoon (2003) reported that depending on irradiation, sacomere length (myofibril units) of chicken breast meat shown meaningful difference and sacomere width (myofibril diameter) also changed after 14 days at 4℃.**

**Table 1. Sarcomere lengths of duck breast meat using by TEM (nm)**

| Temp. \ Days | Sarcomere lengths (nm) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 5 | 7 |
| 0℃ | 1,326.8±5.3 | 1,354.6±26.6 | 1,916.0±40.4 | 2,062.2±34.6 | 1,755.6±181.6 | 1,792.5±35.1 |
| 4℃ | | 1,732.1±43.9 | 2,009.1±58.5 | 1,864.0±165.4 | 1,921.2±80.2 | - |

## IV. CONCLUSION

**Ultrastructural changes of duck breast meat was carried to using TEM aging at 0℃ and 4℃. As aging progressed, myofibrils damage increased and Z-line, I-band, A-band and M-line were damaged compare to earlier stage. Myofibrils collapsed with substantial cut in Z-line but also with M-line cuts. Two days after, comparing with the breast meat after the slaughter immediately at 0℃, myofibrils were widened. After 5 days, ultrastructural changes aging process at 4℃, mitochondria and other organisms filled up the gaps between myofibrils. Also, Sarcomere length was influenced by temperature.**

**In conclusion, following the aging process, significant ultrastructural change can be found after 3 days of aging , though it differs depending on the temperature.**

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- **The objective of this study was to find appropriate aging condition, and it was carried to changes in nucleotide compounds of duck meat during aging. Forty-five days old Peckin ducks were storaged for 7 days in stable temperature at 0℃ and 4℃. ATP and AMP contents were wasted in breast and leg meat immediately. ADP and AMP did not show any tendency between breast and leg meat. Regardless of parts and temperature, the amount of IMP showed the highest at 0 day and then it rapidly decreased until 7 day. After 7 days at 0℃ and 5 days at 4℃, IMP and hypoxanthine contents of breast meat showed similar results respectively between 0℃ and 4℃. In breast meat, IMP contents of was lower and hypoxanthine was higher at 4℃ than that of 0℃ . IMP contents did not difference between breast and leg meat. Inosine contents of breast meat showed about 2 times contents higher tendency but showed not differences between 0℃ and 4℃ of aging temperature.**