EFFECTS OF FASTING TIME BEFORE SLAUGHTERING AND STORAGE TEMPERATURE ON THE BIOCHEMICAL AND HISTOLOGICAL CHARACTERISTICS OF DUCK MUSCLE

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The objective of this study was to investigate the effects of fasting time before slaughtering and storage temperature on the biochemical and histological characteristics of duck muscle. Fourty marketed mule ducks (body weight: 3.2-3.5kg, feeding peroid: 85-90 days)were divided into four lots, and four different fasting time (4 ,8 ,12 ,24 hours) plus enforced exercise were performed.The carcasses were then stored in different temperature conditions to study their biochemical and ultrastructure changes.
The pH values of Blood were high as fasting time extended, and the pH values of duck muscle obtained from the carcasses 24 hour postmortem had same trends. But the pH values of thigh muscle was highly significant higher than that of breast muscle.The content of glycogen of duck muscle decreased as fasting time increased , and the glycogen content of thigh muscle was significant lower than that of breast muscle. The WHC from the longer fasting time ducks were higher than that of the samples from the shorter fasting time ducks. The normal color was observed in the breast of duck which were fasted for 4and 8 hours. However, the DFD-like muscle was observed in the breast of ducks fasted for 12 and 24 hours. Microbial counts, WHC ,pH of muscle stored at different temperature were determined. The changes of SDS-PAGE behavoir and ultrastructure of duck muscle were also studies.

INTRODUCTION

Duck production is one of the important poultry industries. The duck meat has the highest exportable potentiality among the poultry products. Taiwan is located in the sub-tropical area It usually causes the animal seriously stressed as they are transported to the slaughterhouse. In plant , ducks often were handled improperly and stressed, and resulted in abnormal duck muscle such as DFD- like muscle . This problem does affect the quality of duck meat and make the processors lost economically. Thus,how to solve this problem is very important.
The purpose of this study was to investigate the effects of fasting time and enforcing exercise before slaughtering and storage temperature on the biochemical and histological characteristics of duck muscle.

MATERIALS AND METHODS

Experiment animal

Fourty marketed mule ducks(body weight:3.2-3.5kg , feeding peroid: 85-90 days).

Experiment treatments

Fourty marketed mule ducks were divided into four lots and four different fasting time (4 ,8 ,12 ,24 hours) and stress (enforced exercise 15 mim.) were performe. The ducks were only provided clean water during fasting peroid. The breast and thigh muscles were taken out from the undefeathered duck carcasses after bleeding. The excised muscle were divided into 2 lots and stored at 4°C and 25°C.

Biochemical analysis

50 ml of duck blood was collected from bleeding and determined the pH of blood with pH meter (HI8428, HANNA Instrument). The pH and temperature of muscle were measured at 0, 45 min.,and 24 hours postmortem. 0.5 g of breast muscle or thigh muscle were taken from the carcasses after bleeding and stored in liquid N_2 for glycogen content determination. The glycogen contents of muscle were determined according to the procedure of Nuss and Wolf (1980). The meat color was measured with color difference meter and optically observed the color grade. the color grade was divided into 5 grades· 1-pink red , 2-cheery red , 3-red , 4-slight dark red , 5-dark red. The water holding capacity (WHC) and total plate counts were measured according to the procedure of Ockerman(1974).

Muscle protein electrophylsis

The breast muscle obtained from the carcass of the duck fasted for 4 hours. The sarcomplasmic and myofibrillar protein were prepared according to the procedure described by Goll and Robson(

1967). The SDS-polyacrylamide gel electrophylsis was prepared and performed according to the procedure described by Chen(1977).
Transmission electron microscope(TEM)
The breast muscle obtained from the ducks fasted for 4 and 24 hours, and the samples were prepared as described by Duston(1974) and Chen (1977). The ultrastructure of muscle tissue was examined and recorded by JEM 200CX transmission electron microscope operated at 60 kv.

RESULTS AND DISSCUSSION
The pH values of blood were high as fasting time extended, and the pH values of duck muscle obtained from the carcasses 24 hour postmortem had same trends. The pH value of thigh muscle was significantly higher than that of breast muscle but the glycogen content of thigh muscle was significantly lower than that of breast muscle (Table 1). The glycogen content of duck muscle (breast and thigh) decreased as fasting time increased(Table 1) and the result was similar to the reports of Crouse et al.(1984)and Sayre et al. (1963) . The decline rate of pH in muscle was slow as the fasting time increased and that of muscle stored at 4°C was slower than that of muscle stored at 25°C. (Fig. 1). The WHC of duck muscle obtained from the longer fasting time ducks was higher than that of the samples obtained from the shorter fasting time ducks. The WHC of breast muscles was higher than that of thigh muscles(Table 2). L values of muscle decreased as fasting time increased. The normal color was observed in the breast of ducks which were fasted for 4 and 8 hours. However, the DFD-like (Dark,Firm,Dry) muscle color was observed in the breast muscle of ducks which were fasted for 12 and 24 hours(Table 1). Total plate counts were the highest in the samples from the ducks were fasted for 24 hours and stored 24 hours and that of muscles stored at 4°C was lower than that of muscles stored at 25°C (Table3). The result was similar to the reports of Newton and Gill (1980-81) and Robert et al.(1981). A component with molecular weight between 63 and 54 Kdalton was detected on the electrophoretograms of the samples stored at 25°C for 24 hours and the samples stored at 4°C for 48 hours. The intensity of this component increased as storage time increased, and the intensity of 30,000 and 27,000 dalton components also increased as storage time increased. The changes of duck muscle stored at 25°C were significantly serverer than those of duck muscle stored at 4°C.(Fig.2).
The changes of ultrastructure of duck muscle, H-zones and M-lines were weakened, and Z-lines were disrupted. Sarcomplasmic reticulum and mitochondria disappeared rapidly during postmortem storage. These conditions were observed in the samlpes of duck which were fasted for 24 hours and stored at 25°C for 24 hours(Fig. 4). The ultrastructural changes of duck muscle were considerable and large, when the samples were stored at 25°C for 72 hours(Fig. 4). However ,the ultrastructural changes of duck muscle obtained from the 4 hour fasted ducks stored at 4°C and 25°C were smaller than those of the samples obtained from the 25 hour fasted ducks (Fib. 3), and all the samples stored at 4°C were more stable than those stored at 25°c.

CONCLUSION
These results were noted that the improper handling of the duck preslaughter could result in DFD-like duck meat and shorten the shelf-life of the product. Thus, it was very important to reduce the stresses to the duck preslaughter to produce good quality of the product.

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Table 1 : The effect of different fasting time on the quality of duck muscle.

Item \ Fasting time (hr.) / Part	4		8		12		24	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
Blood pH	7.62^{c}		7.72^{d}		7.78^{e}		7.81^{e}	
Meat temperature(°C) 0 hr.	38.6^{c}	37.0^{c}	39.1^{d}	38.7^{d}	38.3^{c}	36.3^{g}	39.7^{h}	38.4^{c}
45 min	27.4^{c}	25.5^{d}	28.2^{c}	28.4^{c}	29.7^{f}	28.3^{c}	30.3^{f}	30.4^{f}
45 min	6.13^{c}	6.20^{c}	6.28^{d}	6.60^{e}	6.73^{f}	6.63^{e}	6.28^{d}	6.70^{f}
Meat pH 24 hr.	5.72^{c}	6.30^{d}	5.61^{c}	6.47^{e}	5.90^{f*}	6.70^{g*}	6.06^{h*}	6.90^{i*}
Glycogen (mg/g)	2.07^{c*}	1.84^{d*}	1.34^{e*}	1.15^{e}	0.87^{f}	0.66^{g}	0.66^{g}	0.55^{g}
45 min	30.3^{cx}	32.0^{dx}	28.7^{ex}	33.5^{fx}	30.0^{cx}	33.2^{fx}	27.5^{gx}	32.32^{dx}
L value (%) 24 hr.	31.3^{cx}	29.9^{dy}	29.7^{d*y}	31.3^{cy}	28.1^{f*y}	32.5^{gx}	27.8^{h*x}	31.04^{cx}
45 min	1.66^{cx}	1.86^{hx}	1.77^{d*x}	1.86^{h*x}	1.47^{ex}	1.75^{gx}	1.56^{fx}	1.51^{fx}
W H C 24 hr.	1.58^{c*x}	1.63^{cy}	1.25^{ey}	1.34^{fey}	1.32^{fex}	1.31^{ey}	1.26^{ey}	1.39^{fy}
Grade of color	2.16^{c}		1.33^{d}		2.66^{c}		3.33^{e*}	

a
Blood is obtained from bleeding and used for pH test.

b
Color evaluated by 5 grades: 1-pink, 2-cherry red, 3-red, 4-slight black red, 5-black red.

Data within horizontal rows with different letters (c,d,e,f,g,h,i) are significant difference($P<0.05$), * is highly significantly different ($P<0.01$).

Data within vertical columns in the same items, with different letters (x,y) are significant difference($P<0.05$).

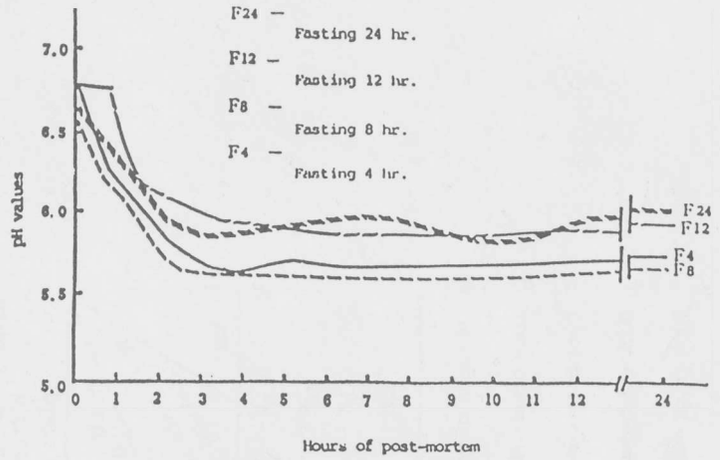
Table 2 : The effects of different fasting time before slaughter and different temperature during postmortem storage on the water holding capacity[a] of duck muscle.

Fasting time (hr.)	Part	Storage temperature (°C)	Storage time (hr.)	Water holding capacity 0.75	12	24
4	Breast	4		1.62	1.56	1.43^{b*}
		25		1.66	1.52	1.58^{c}
	Thigh	4		1.85	1.76^{b}	1.60 *
		25		1.86	1.92^{c*}	1.63 *
8	Breast	4		1.59^{b}	1.58	1.34 *
		25		1.77^{c*}	1.58	1.25 **
	Thigh	4		2.24^{d}	2.23^{d}	1.47^{c**}
		25		1.86^{b*}	1.80^{b}	1.34^{d} **
12	Breast	4		1.46	1.44	1.37
		25		1.47	1.37	1.32
	Thigh	4		1.66	1.44^{*e}	1.37 **
		25		1.75	1.33^{**f}	1.31 **
24	Breast	4		1.34^{f*}	1.53^{b}	1.39^{b}
		25		1.56^{b}	1.32$^{* f*}$	1.26^{c***}
	Thigh	4		1.66^{e*}	1.52	1.41 *
		25		1.51^{b}	1.49	1.39

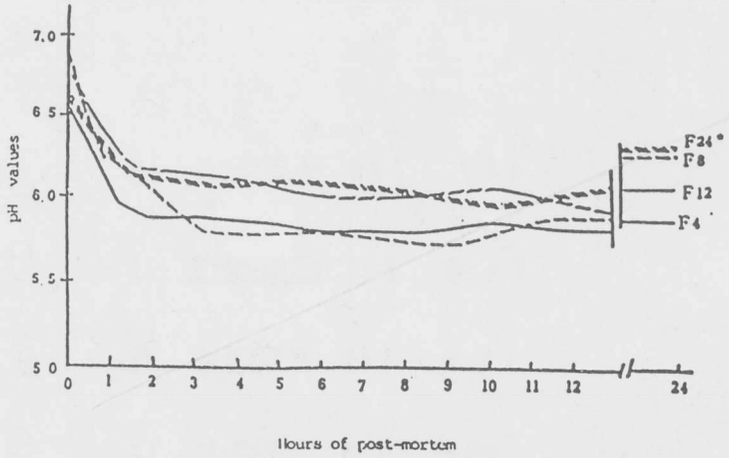
a:
Water holding capacity: Total press areas/meat press areas.

Data within horizontal rows with * is significant difference ($P<0.05$); ** is highly significantly different ($P<0.01$).

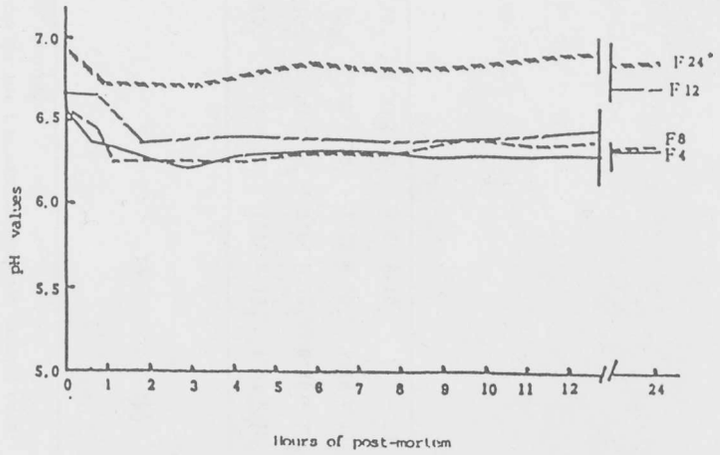
Data within vertical columns in the same items with different letters (b,c,d,e,f) are significant difference ($P<0.05$), * is highly significantly different ($P<0.01$).



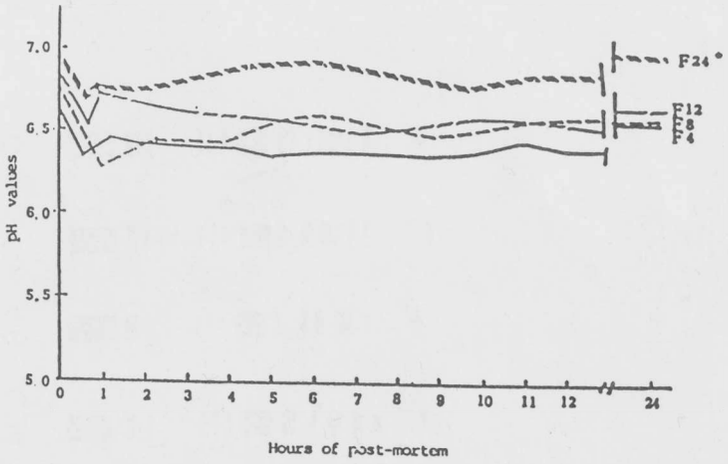
The changes of pH of duck breast muscle samples obtained from different fasting time plus stressing before slaughter during postmortem storage at 25°C.



The changes of pH of duck breast muscle samples obtained from different fasting time plus stressing before slaughter during postmortem storage at 4°C.



The changes of pH of duck thigh muscle samples obtained from different fasting time plus stressing before slaughter during post-mortem storage at 25°C.



The changes of pH of duck thigh muscle samples obtained from different fasting time plus stressing before slaughter during postmortem storage at 4°C.

Fig. 1 The changes of pH of duck muscle (breast and thigh) obtained from different fasting time before slaughter during postmortem storage at 4°C and 25°C.

Table 3 The effects of different fasting time before slaughter and different temperature during postmortem storage on the total plate counts of duck muscle[a].

Lot \ Fasting time (hr.) / Total plate counts (cell/g)	4	8	12	24
B[b]	8.84×10^7	1.93×10^8	1.78×10^8	1.97×10^8
CB[c]	8.10×10^5	6.70×10^6	7.64×10^6	8.40×10^6
T[d]	1.18×10^8	1.95×10^8	1.35×10^9	1.48×10^8
CT[e]	8.84×10^5	6.30×10^6	3.04×10^6	8.2×10^6

a 24 hours of postmortem.

b Duck breast muscle stored at 25°C.

c Duck breast muscle stored at 4°C.

d Duck thigh muscle stored at 25°C.

e Duck thigh muscle stored at 4°C.

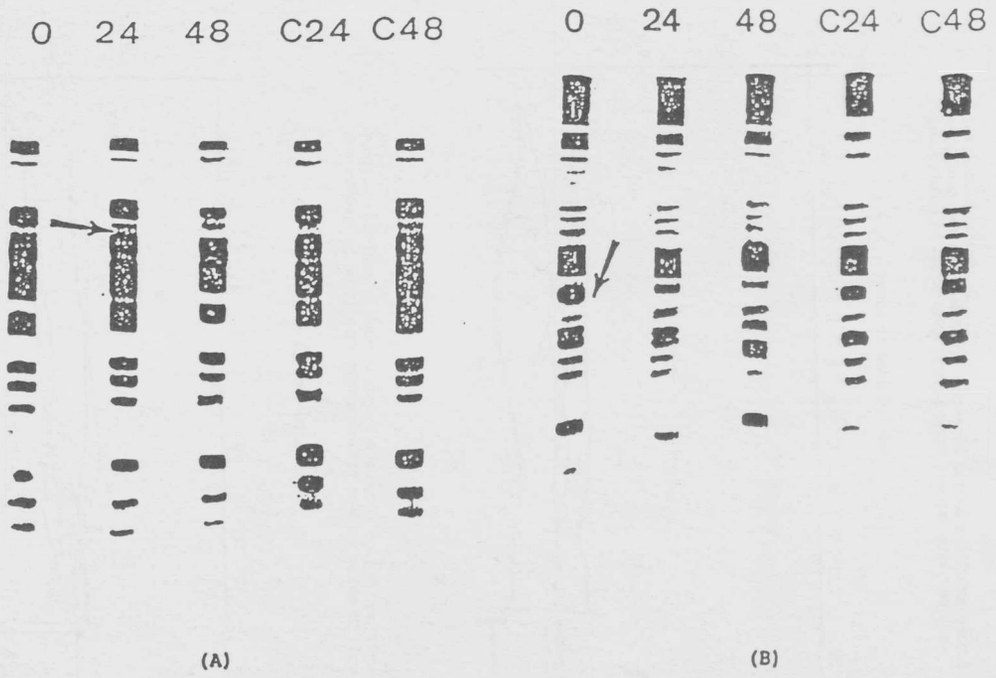
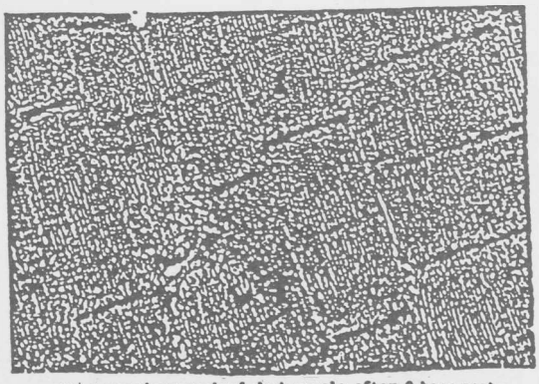
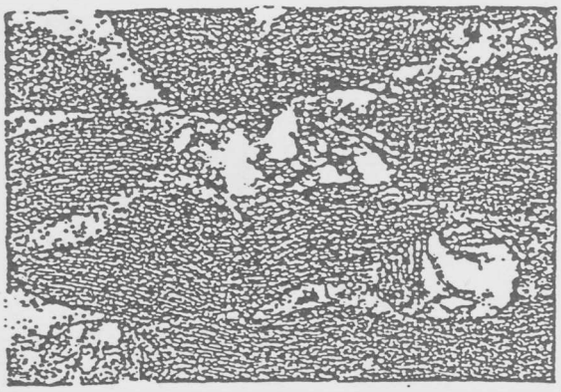


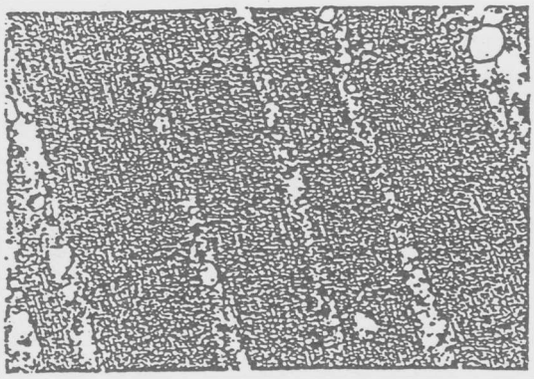
Fig. 2 : Comparison of SDS electrophoretic patterns of sarcomplasmic (A) and myofibrill ar (B) fractions stored in different temperature ((C) 4°C, 25°C).
Note: The numbers on label indicated hours of storage.



Electron micrograph of duck muscle after 0 hour post-mortem (fasting 4 hrs. plus stressing before slaughter). (28,000X).

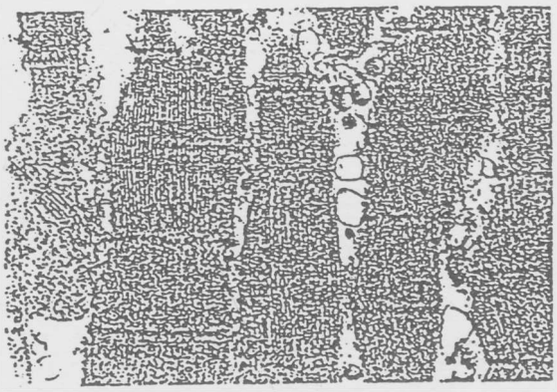


Electron micrograph of duck muscle after 24 hours post-mortem at 4°C (28,000X).

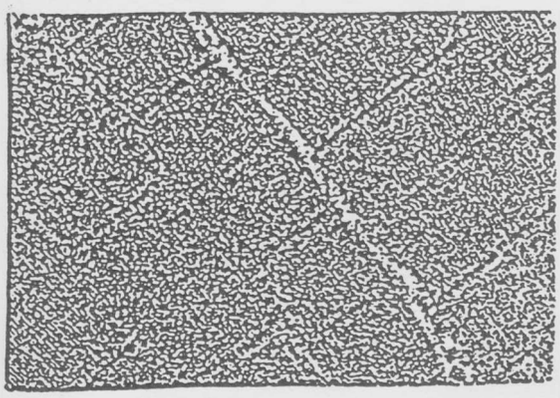


Electron micrograph of duck muscle after 24 hours post-mortem at 25°C (28,000X).

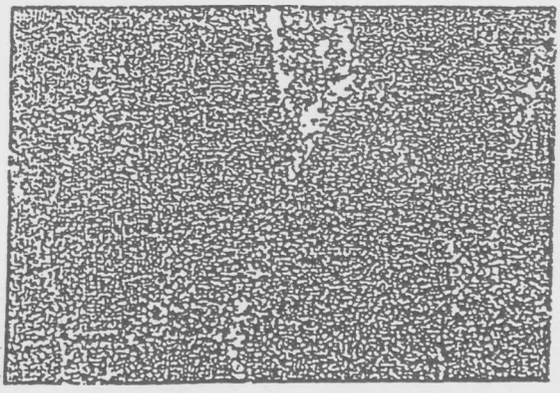
Electron micrograph of duck muscle after 48 hours post-mortem at 4°C (28,000X).



Electron micrograph of duck muscle after 48 hours post-mortem at 25°C (28,000X).

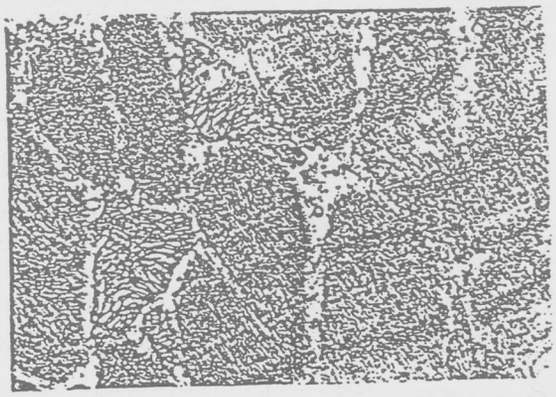


Electron micrograph of duck muscle after 72 hours post-mortem at 4°C (28,000X).

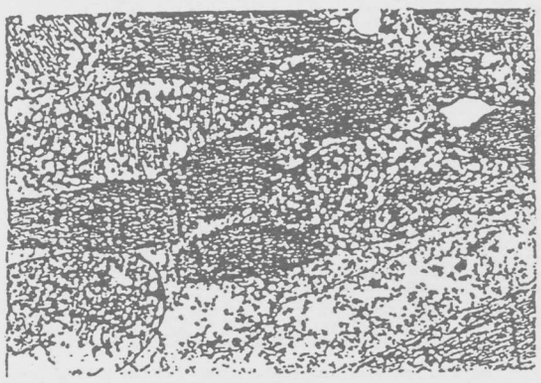


Electron micrograph of duck muscle after 72 hours post-mortem at 25°C (28,000X).

Fig. 3 Electron micrograph of duck breast muscle obtained from 4 hours fasting time and stored at 4°C and 25°C.

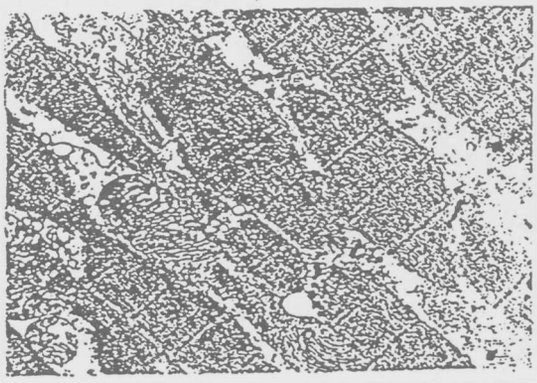


Electron micrograph of duck muscle after 0 hours post-mortem (fasting 24 hus. plus stressing before slaughter).(28,000X).

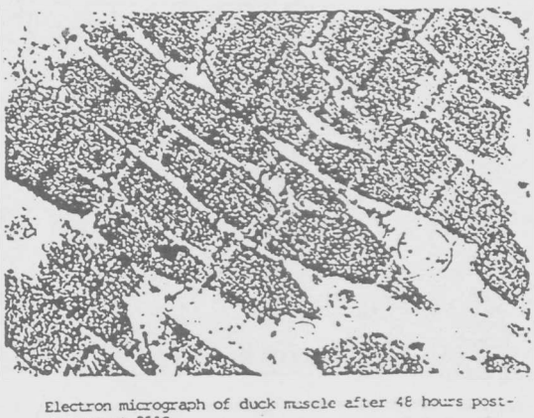


Electron micrograph of duck muscle after 24 hours post-mortem at 4°C (28,000X).

Electron micrograph of duck muscle after 24 hours post-mortem at 25°C (28,000X).

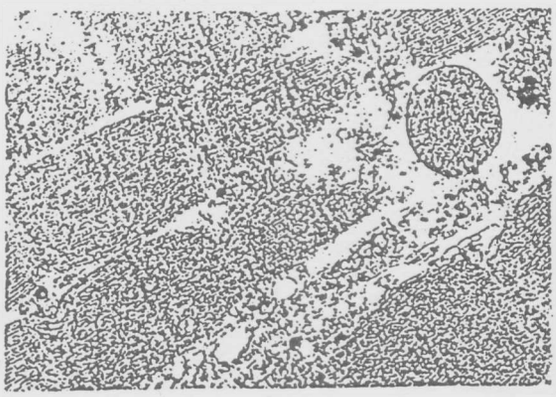


Electron micrograph of duck muscle after 48 hours post-mortem at 4°C (28,000X).



Electron micrograph of duck muscle after 48 hours post-mortem at 25°C (28,000X).

Electron micrograph of duck muscle after 72 hours post-mortem at 4°C (28,000X).



Electron micrograph of duck muscle after 72 hours post-mortem at 25°C (28,000X).

Fig. 4 Electron micrograph of duck breast muscle obtained from 24 hours fasting time and stored at 4°C and 25 °C.