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# Carcass Characteristics and Qualities of Philippine White Mallard (*Anas boschas* L.) and Pekin (*Anas platyrhynchos* L.) Duck

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***Abstract*****—**The Philippine White Mallard duck was compared with Pekin duck for potential meat production. A total of 50 ducklings were randomly assigned to five (5) pens per treatment after one month of brooding. Each pen containing five (5) ducks was considered as a replicate. The ducks were raised until 12 weeks of age and slaughtered at the end of the growing period. Meat from both breeds was analyzed. The data were subjected to the Independent-Sample T-test at 5% level of confidence. Results showed that post-mortem pH (0, 20 minutes, 50 minutes, 1 hour and 20 minutes, 1 hour and 50 minutes, and 24 hours ) did not differ significantly ($P>0.05$) between breeds. However, Pekin ducks (89.84±0.71) had a significantly higher water-holding capacity than Philippine White Mallard ducks (87.93±0.63) ($P<0.05$). Also, meat color (CIE L, a, b) revealed that no significant differences among the lightness, redness, and yellowness of the skin (breast) in both breeds ($P>0.05$) except for the yellowness of the lean muscles of the Pekin duck breast. Pekin duck meat (1.15±0.04) had significantly higher crude fat content than Philippine White Mallard (0.47±0.58). The study clearly showed that breed is a factor and provided some pronounced effects among the parameters. However, these results are considered as preliminary information on the meat quality of Philippine White Mallard duck. Hence, further studies are needed to understand and fully utilize it for meat production and develop different meat products from this breed.

***Keywords*****—**Crude fat, meat quality, water-holding capacity.

## I. Introduction

DUCKS rank second to chicken in terms of providing good quality eggs in the Philippines. They are the most versatile avian species that are of commercial significance due to their ability to subsist in a wide range of climatic and nutritional conditions [23]. It was reported that ducks are relatively hardy and resistant to common avian diseases and can feed on a variety of food [6]. In the Philippines and other South East Asian countries, the practice of flocking ducks is common in rice-growing regions [13]. One of it is the Philippine White Mallard duck which is utilized for an egg-type breed. However, due to its low egg production rate, farmers do not raise them for that purpose. A large number of these ducks are found in the Philippines but they are never utilized for commercial production. Clean-looking duck carcasses are produced from Philippine White Mallard due to their white plumage. Hence, this study aimed to determine the potential of Philippine White Mallard duck for meat production. Carcass characteristics and qualities were considered as it directly affects the water binding- retention, freshness, physical attributes, and proximate compositions of duck meat.

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## II. Materials and Methods

### *A. Experimental Treatment and Design*

The Philippine White Mallard and the Pekin ducks were the two breeds considered as an experimental treatment. The ducks were randomly assigned to five (5) pens per treatment. Each pen containing five (5) ducks was considered as a replicate. A complete randomized design (CRD) was followed and used during the experiment.

### *B. Experimental Animals*

The Philippine White Mallard and Pekin duck eggs were provided by the Bureau of Animal Industry-National Swine and Poultry Research and Development Center (BAI-NSPRDC) in Lagalag, Tiaong, Quezon. A total of fifty (50) duck eggs composed of 25 eggs per breed (Philippine White Mallard and Pekin ducks) were used.

### *C. Incubation Management*

A total of 100 eggs were incubated for 28 days at BAI-NSPRDC using a force draft artificial incubator. Before these eggs were set in an incubator, 1st candling was done to determine if the egg was fertile or not. Once fertile, these eggs were set in the incubator at 99.5°C and 65-70% relative humidity (RH) with an automatic turning 2 to 3 times a day to facilitate an ambient condition of a developing embryo. After 19 days of incubation, 2nd candling was facilitated to make sure that there was a developing embryo from a fertile egg. Those dead embryos detected during 2nd candling were removed from the incubator and sold as *penoy* to the retailers. Out of 100 eggs set in the incubator, only 50 eggs (25 eggs from each Philippine White Mallard and Pekin ducks) were hatched. Afterwards, newly hatched ducklings were released for segregation and distribution for brooding period.

*D. Brooding Management*

After incubation, newly hatched ducklings were separated according to breed and brooded for 1 month. The ducklings were kept in a battery brooder house with an incandescent bulb as an artificial source of heat. Duck starter mash was given twice a day and the ducks were provided with fresh and clean water.

*E. Rearing and Growing Management*

Before rearing and growing period started, sexing was done to attain the sex ratio of 2 males: 3 females of ducklings to each pen. The ducklings were randomly assigned to the growing pens and were raised for two months. The growing pens used are not equipped with pond. *Ad libitum* feeding system was followed. A commercial duck grower mash was used and dispensed on the feeders twice every day. The duck grower mash was composed of the following feed ingredients: yellow corn, soya, copra meal, pollard, limestone, biofos, coco oil, D-1, molasses, and duck grower concentrate. The calculated proximate compositions were 7.41% moisture, 15.27% crude protein, 2.93% crude fiber, 4.85% crude fat, and 5.24% ash.

*F. Dressing*

After two (2) months of growing, only forty-three out of fifty (43 out of 50) of the experimental ducks were transported and brought to the Animal Processing and Product Utilization Division of the Animal and Dairy Sciences Cluster (ADSC), College of Agriculture-UPLB. The ducks from brooding to growing periods were 12 weeks old approximately.

They were brought in at twelve midnight (12 A.M.) to ensure that they relaxed, lessen the amount of stress, as well as to facilitate fasting within 4-6 hours.

The live weights were recorded. The procedures for dressing the ducks were followed [17].

The interval of dressing per replicate was about 20 minutes to facilitate the monitoring of muscle pH every 30 minutes within 2 hours (only one bird per replicate was used for muscle pH monitoring). The final pH color and water-holding capacity were gathered after 24 hours of chilling.

Weighing and recording of the remaining dressed carcasses were done in the fabrication room. Breast meat samples were taken from right side and stored in a zip lock plastic and kept in a freezer for proximate analyses.

*G. Physico-Chemical Properties*

1. pH

The right-side part of the breast muscle of the dressed carcass was incised and the pH meter was inserted after the development of watery meat surface after few seconds [3]. A pH 600 pocket-sized meter (Milwaukee Rocky Mount- NC, USA) and calibrated at pH 4.0, 7.0, and 10 was used.

2. Water- Holding Capacity

It was determined using the press method [27]. Approximately 0.5g sample was taken from the breast portion and weighed into a 9cm diameter Whatman No 1 filter paper (Model C, Carver, Inc Wabash IN, USA) and pressed for 1 min at 500 psi. The meat and total film areas were measured for free water (%) using a compensatory polar planimeter (Planix 5000, Tamaya Technics Inc, Tokyo, Japan). It was calculated based on sample weight and moisture content [27]. The formula used was shown below:

$$\% \text{ free water} = \frac{(\text{total film area in2} - \text{meat film area in2})\ 61.10}{\text{total moisture in sample}} * 100$$

where 61.10 factor = regression coefficient milligram water per square inch moisture of sample should be given in mg. Percent bound water (WHC) was calculated as 100% minus free water percent.

3. Color

The surface color of both skin and *pectoralis* muscle (breast muscles) samples were determined in a cold room (18°C). Transparent cellophane was used and placed in both the surface of the skin and breast muscles before measuring the color values to prevent any accumulation of water in the device for measurement. However, in the color of breast muscles, incising at the right side was done and let it exposed for 45 minutes to an air conditioned room (18°C) to allow the blooming of the meat color [24]. Blooming was done so that color will be enhanced due to the oxygenation process of myoglobin molecule resulting to a bright red muscle color.

The color was determined using a chromameter (CAPSURE-PANTONE X-Rite, USA). The color values were measured three times at different points on the surface of each carcass while six times on the muscles. The same measuring points were used for all the samples. The expression of color was characterized as CIE color indexes L*, a*, b*, where L* indicates the lightness, a* represents the color axis from green to red, and b* represents the color axis from blue to yellow.

*H. Proximate Composition*

The moisture, ash, crude protein, and crude fat contents of the muscle samples were determined [4]. Pure lean samples of the breast (right side) were used in the analysis**.**

*I. Statistical Analysis*

The data on physico-chemical properties and proximate compositions of meat from Philippine White Mallard and Pekin ducks were analyzed using an Independent-Sample T-test at 5% level of confidence.

## III. Results and Discussion

Mortality has occurred on the growing period due to drowning brought by a signal number three typhoon (Glenda) which hit in the province of Quezon last July 16, 2014. Therefore, forty-three out of fifty (43 out of 50) experimental animals were used for the analyses.

*A. Physico-Chemical Properties*

The freshness, water holding capacity, and quality of the muscles, or lean, after slaughtering and chilling are the topmost concerns and factors to consider due to the influence in the

characteristics and qualities of meat from Philippine White Mallard and Pekin ducks.

1) pH

Table I shows the changes in meat pH values of Philippine White Mallard and Pekin ducks' breast muscles at different time intervals post-mortem. The ducks were 12weeks old, raised under similar production systems, and subjected to the same protocols/methods of dressing. The meat pH values did not differ significantly between the two breeds (P>0.05). The breeds of duck do not mark the pH value of breast meat [21], [18]. Although, meat pH values from Pekin ducks were fluctuating, the ultimate or final pH at 24 h post-mortem of 6.0 was relatively the same with Philippine White Mallard ducks and within the normal pH range of 5.4 to 6.3 of duck meat [8].

To compare with other poultry species, there is no significant differences (P>0.05) in pH values between chicken and duck meat at the same post-mortem time except at 30 minutes [2]. Furthermore, it was noted that meat pH declines gradually after post-mortem, but ultimate pH values were the same after 24 hours in both breeds. However, different pH values of chicken and duck breast muscle at 30 min, 1 h, and 4 h post-mortem [26], yet the ultimate pH at 24 h are similar.

However, differences in pH values were found in the same muscle of different strains within the same poultry species [10]. It was supported by the various results of pH values from A44 and A55 strains of ducks that the average pH at 24-hour post-mortem is between 6.0 and 6.4 [20]. On similar strain (A44 Pekin) of duck at different ages, lower pH values (5.71 to 5.77) were recorded after 24 hours of slaughtering on its breast, thigh, and shank muscles, respectively [28].

The gradual changes of the meat pH indicate that post-mortem glycolysis took place at a normal rate. It also proved that no signs of PSE (Pale, Soft, and Exudative) or DFD (Dark, Firm, and Dry) were observed from the meat of Philippine White Mallard and Pekin ducks brought by the changes of meat pH after dressing and chilling.

TABLE I
MEAT PH OF PHILIPPINE WHITE MALLARD AND PEKIN DUCKS

| | Breed | | |
|---|---|---|---|
| Time at post-mortem | Philippine White Mallard | Pekin | P-value |
| Initial | 6.70±0.19 | 6.66±0.15 | 0.72 |
| 20 mins | 5.92±0.24 | 6.04±0.05 | 0.30 |
| 50 mins | 5.98±0.08 | 5.98±0.04 | 1.00 |
| 80 mins | 5.90±0.07 | 5.90±0.07 | 1.00 |
| 110 mins | 5.94±0.05 | 5.88±0.08 | 0.21 |
| 1440 mins | 6.00±0.10 | 5.88±0.13 | 0.14 |

Means are not significantly different (P>0.05).

2) Water-Holding Capacity

The primary indicator of the degree of juiciness of meat is water-holding capacity [22]. It is the ability of meat to retain its water upon the application of external forces [11].

Table II shows the amount of free and bound water of meat from the two breeds of duck. The results indicate that Pekin has a higher water binding capacity (WHC) than PWM (Philippine White Mallard). Since the ducks were subjected to similar post-production handling, the differences in WHC could be attributed to breed effect. Pekin being a meat-type breed is more muscular hence, more water molecules are tightly bound within the lean tissues. Higher percentages of bound water were recorded in both Philippine White Mallard and Pekin ducks and with similar results and management regime applied in growing the ducks [22]. Moreover, Pekin is significantly different from (71.06%) other breeds of duck (Muscovy and Rouen) in terms of water-holding capacity [22]. The results of the current experiment showed also that free water of both breeds were in the normal range of 8.7 to 19.1 % on breast, thigh, and shank muscles of an A44 strain of Pekin ducks raised under intensive and unlimited feeding systems [28]. It only means that after processing of duck meat such as grinding or comminution, minimal loss/drip loss/purge occurred around the muscle membranes.

TABLE II
FREE AND BOUND WATER OF MEAT FROM PHILIPPINE WHITE MALLARD AND PEKIN DUCKS

| | Breed | | |
|---|---|---|---|
| Water Form | Philippine White Mallard | Pekin | P-value |
| free water | 12.07±0.63a | 10.17±0.72b | 0.03 |
| bound water | 87.93±0.63b | 89.84±0.71a | 0.03 |

Means within row followed by different superscripts are significantly different (P<0.05).

3) Color

The typical red color of fresh duck meat is caused by myoglobin and its derivatives which constitute about 90 % of meat pigment as well as in the presence of hemoglobin and other chemicals [27].

Table III shows both the color of the skin and breast muscles based on CIE L*, a*, and b* values of Philippine White Mallard and Pekin ducks. No significant differences (P>0.05) were observed among the meat color parameters except for the yellowness (b*) (P<0.01) in breast muscles. The significant differences of the yellowness of breast muscles between Pekin and Philippine White Mallard ducks are attributed to the relative effects of breed [12]. It was noted that Pekin ducks have performed better in body weight gain and feed conversion ratio compared to Philippine White Mallard duck [19]. Therefore, it is expected that Pekin tends to produce more fat which is one of the nutrients for body mass development (Table IV).

However, the other factors affecting the meat color aside from the breed is diet which is known factor to contribute in meat color [7]. The ducks ingest high amounts of corn containing liposoluble xanthophylls that accumulate in tissues during overfeeding [7]. It is supported that breast muscle of overfed mule ducks was paler and had higher b* values than breast muscle of ducks fed *ad libitum* [25], [9]. Also, confirmed that meat color is dependent on primary production factors such as species, breeds, and age of animal and nutritional status [12] and on different breeds of duck [15].

Meanwhile, there are other factors known to affect meat color in ducks such as pre-slaughter period, the slaughter process, and subsequent processing. Of which it will influence the meat color by the changes and conditions of both physical

and chemical attributes such as changes in pH and temperature during storage and display that leads to oxygenation and oxidation of myoglobin [12].

Lastly, duck breast meat in the present study contained higher redness (a*) but lower lightness (L*) value compared to chicken and the skin of duck [2]. The result showed and proved that the color of duck meat is red or dark based on its fiber contents within the muscles compared to other poultry species. The variations of the color among the poultry species were due to the compositions of muscle fibers in which the breast muscle from ducklings contained approximately 16% white fibers and 84% red fibers compared to 100% white fibers in chicken breast muscle [26].

TABLE III
COLOR PARAMETERS OF MEAT FROM PHILIPPINE WHITE MALLARD AND PEKIN DUCKS

| | Breed | | |
|---|---|---|---|
| | Philippine White Mallard | Pekin | P-value |
| Breast (Skin) | | | |
| L* | 74.67±2.94 | 73.63±2.53 | 0.563 |
| a* | 2.93±1.6 | 2.32±1.13 | 0.507 |
| b* | 23.89±3.38 | 23.41±4.12 | 0.844 |
| Breast (Lean) | | | |
| L* | 35.59±1.59 | 36.60±2.62 | 0.479 |
| a* | 11.46±1.25 | 10.75±1.87 | 0.499 |
| b* | 9.43±1.22b | 11.87±0.88a | 0.007 |

Means within row followed by different superscripts are significantly different at P<0.05.

### *B. Proximate Composition*

The factors that influence the chemical composition of duck meat are duck's origin, age, and nutrition which are crucial for the culinary value and technological properties of duck meat [31], [30], [16].

TABLE IV
PROXIMATE COMPOSITION OF MEAT OF PHILIPPINE WHITE MALLARD AND PEKIN DUCKS

| | Breed | | |
|---|---|---|---|
| Component | Philippine White Mallard | Pekin | P-value |
| Moisture | 74.51±0.44 | 75.22±0.33 | 0.09 |
| Crude protein | 22.48±0.65 | 22.63±0.27 | 0.72 |
| Crude fat | 0.47±0.58b | 1.15±0.04a | 0.00 |
| Ash | 1.09±0.09 | 0.96±0.02 | 0.07 |

Means within row followed by different superscripts are significantly different (P<0.05).

### *C. Moisture*

The breast muscles of the Philippine White Mallard and Pekin showed no significant differences (P>0.05) on the moisture contents (Table IV) which indicates that the breed effect has no impact on the amount of moisture of the meat. The result could be attributed to similar age of the ducks (12 weeks old) and the same protocols/methods of slaughtering. Similar results were manifested in which no significant differences in moisture content were found among Rouen, Pekin, and Muscovy ducks as well in A44 strain of Pekin under intensive and unlimited feeding systems [22], [28].

### *D. Crude Protein*

The crude protein from the muscles of both Philippine White Mallard (22.48%) and Pekin (22.63%) shows no significant differences between each other. However, the results ascertained that the substantial protein contents of duck meat in both breeds are a product of efficient nutritional management during rearing [28]. It clearly indicates that breed and other factors (age and specific muscles) have no significant (P>0.05) effect on the protein content since the experimental ducks were raised under the same management systems and subjected to similar post-mortem protocols.

Additionally, the values of crude protein from the cureent study are within the range and that in A44, A55, Pekin ducks'breast and leg muscles which contained 21.1% and 20.7%, and 21.5% and 22.5%, respectively [30], [5]. However, smaller amounts of crude protein detected on breast muscles (19.4 to 20.7 %) and leg muscles (18.7 to 19.5 %) of A44 strain of Pekin ducks [28].

### *E. Crude Fat*

The fat contents in breast muscles of Philippine White Mallard and Pekin duck are significantly different from each other (P<0.01). The result could be attributed to the pronounce effects of breed of which Pekin duck (1.15%) has a higher percentage of fat in breast muscles compared to Philippine White Mallard (0.47%). It was noticeably that breed could be a factor that contributed in the fat contents among the following breeds of duck; Peking, Muscovy, Domyitte, and Sudani under intensive and unlimited feeding systems [10]. The experimental ducks used in this study were similar to the products of the feeding trial and recorded that Pekin ducks have higher feed consumption and gained higher body weight throughout the experiment compared to Philippine White Mallard ducks [19]. These findings have confirmed that Pekin ducks tend to produce more fat compared to Philippine White Mallard under the same production and management systems. Of which this study confirmed on fat levels between these two breeds under the same production and management systems.

A much higher and incomparable fat contents were recorded which ranged from 4.5 to 8.5% in breast muscles of local and Turkish Pekin [14]. However, lower contents of fat were recorded in breast muscle (1.8%) and leg muscles (3.2%) [1], [28]. It is also the same with the breast muscles of Muscovy and Mallard ducks [5], [16], [20], [26].

### *F. Ash*

The ash content of Philippine White Mallard (1.09%) and Pekin duck meat (0.96%) did not differ significantly (P>0.05). Results reveal that the pronounce effects of breed does not influence the ash content. In contrast with the current results, it was revealed that breed contributed to the different ash contents among Muscovy, Sudani, Domyitte, and Pekin ducks [10].

## IV. CONCLUSION

Philippine White Mallard is primarily an egg-type duck but this present study indicates that it can be utilized for meat and

compete with other existing meat-type ducks in terms of physico-chemical properties and proximate compositions.

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## REFERENCES

[1] Adamski, M. 2005. Tissue composition of carcass and meat quality in ducks from paternal pedigree strain.Acta Sci. Pol. Zoot. 4: 3-12
[2] Ali, MD, GH Kang, HS Yang, JY Jeong, YH Hwang, GB Park, and ST Joo. 2007. A Comparison of Meat Characteristics between Duck and Chicken Breast. Asian-Aust. J. Anim. Sci. 20(6):1002-1006
[3] Arganosa, FC and HW Ockerman.1987. The influence of curing ingredients, packaging method and storage on the biochemical and sensory qualities and acceptability of a dried beef product. J. Food Process. Preserve. 12:45-51.
[4] AOAC.1993. Proximate Analysis Procedure
[5] Bons, A, R Timler, and H Jeroch. 1998. Changes in body composition and content of fat and protein in carcass of male and female Pekin ducks during growth. Zesz.Nauk. Prz. Hod.,36: 165-175
[6] Chang, H, C. Dagaas, N De Castro, R Ranola, A. Lambio, and M Malabayuabas. 2003. An overview of the Philippine duck industry. Australian Center for International Agricultural Research.1-26 p.
[7] Chartrin, P, KH Meteau, MD Juin, G Bernadet, C Guy, H Larzul, J Remignon, MJ Duclos, and E Baeza. 2006. Effects of intramuscular fat levels on sensory characteristics of duck breast meat. Poult.. Sci., 85: 914-922.
[8] Erisir, Z, O Poyraz, EE Onbasilar, E Erdem, and GA Oksuztepe. 2009. Effects of housing system, swimming pool and slaughter age on duck performance, carcass and meat characteristics. J. Anim. Vet. Adv., 8: 1864-1869.
[9] Fernandez, X, A Auvergne, M Renerre, P Gatellier, H Manse, and R Babile. 2003. Preliminary observations on the colour variability of breast meat ('magrets') in force-fed ducks. Anim. Res. 52, 567-574
[10] Galal, A, WAH Ali, AHM Ahmed and KH AA Ali. 2011. Performance and carcass characteristics of Dumyati, Muscovy, Peking and Sudani duck breeds. Egyptian J. Anim. Prod. (2011) 48(2):191-202
[11] Hedrick, H.B., E.D. Aberle, J.C. Forest, M.D. Judge and R.A. Merkel. 1994. Properties of fresh meat. In; H.B.Hedrick, E.D. Aberle J.C. Forrest, M.D. Judge and R.A. Merkel (eds), Principle of meat Sci. I.A. Dubuque, Kendall/Hunt Publishing Company., pp: 123-131.
[12] Honikel, K.O. 1998. Reference methods for the assessment of physical characteristics of meat. Meat Science, 49(4), 447-457
[13] Ikani, EI. 2003. Duck production in Nigeria. National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria Nigeria. Extension Bulletin Publication 133(7):1-31.
[14] Isgusar, E, C Kocak, and H Pingel. 2002. Growth, carcass traits and meat quality of different local ducks and Turkish Pekins. Arch. Tierz., Dummerstorf, 45 413-418.
[15] Ismed, HN, and N Ismail. 2013. Physicochemical Analysis and Mineral Composition of Duck Meat (Peking, Muccovy and Local Java).International Journal of Biological, Ecological and Environmental Sciences (IJBEES) Vol. 2, No. 5 ISSN 2277 – 4394
[16] Knust, U and H Pingel. 1992. The effect of initial pH-value in duck breast and thigh muscles on other meat characteristic. Proc. XIXth World's Poultry Congress 221-224
[17] Lambio, AL. 2001. Status, problems and prospect of the duck industry in the Philippines.Unpublished manuscript, Institute of Animal Science, UPLB-CA, College, Laguna.
[18] Lee, HJ, D Jayasena, SH Kim, HJ Kim, KN Heo , JE Song, and C Jo. 2015. Comparison of Bioactive Compounds and Quality Traits of Breast Meat from Korean Native Ducks and Commercial Ducks Korean J. Food Sci. An. Vol. 35, No. 1, pp. 114~120.
[19] Lim, D. 2015. Growth Performance and Carcass Yield of Philippine White Mallard and Pekin ducks. University of the Philippines-Los Banos
[20] Mazanowski, A and J Ksiazkiewicz. 2004. Comprehensive evaluation of meat traits of ducks from two sire strains. J. Anim. Feed Sci. 13:175-184.
[21] Muhlisin, K, DS Song, YR Kim, HR Kwon, HJ An, BK Kang, CW Kim, and SK Lee. 2013. Comparison of meat characteristics between Korean native duck and imported commercial duck raised under identical rearing and feeding condition. Korean J. Food Sci. An. 33, 89-95.
[22] Omojola, AB. 2007. Carcass and Organoleptic Characteristics of Duck Meat as Influenced by Breed and Sex. International Journal of Poultry Science 6 (5): 329-334
[23] Ortizo, KA, AR Cuyacot, JJM Mahilum, HI Rivero, and OM Nuñeza. 2014. Plasma biochemistry levels and hematological parameters in Mallard ducks (Anas platyrhynchos Linn.) from selected semi-free range duck farms in Misamis Occidental and Zamboanga Del Sur, Philippines. ABAH Bioflux 6(1):50-62
[24] Saucier, L, C Gendron, and C Gariepy. 2000. Shelf life of ground poultry meat stored under modified atmosphere. Poultry Science, 79, 1851-1856.
[25] Salichon, MR, E Baeza and B Leclercq. 1997. Biochemical characteristics of Muscovy duck breast. Sciences des Aliments, 17, 227-233.
[26] Smith, DP, DL Fletcher, JR Buhr, and DS Beyer.1993.Pekin duckling and broiler Pectoralis Muscle structure and composition. Poultry Sci. 72 : 202-208
[27] Tsai, TC and HW Oeckerman. 1981. Water holding measurement of meat. Meat Sci. 46:697-701.
[28] Witak, B. 2008. Tissue composition of carcass, meat quality and fatty acid content of ducks of a commercial breeding line at different age. Arch. Tierz., Dummerstorf 51(2008) 3, 266-275
[29] Witkiewicz, K.1998. Comparison of ducks from two breeding strains with regard to some selected live and slaughter traits (in Polish). Rocz. AR Pozań, 302 (1998), 243-251
[30] Witkiewicz, K. 2000. Zoometric measurements, slaughter value and chemical composition of the breast muscle in two strains of ducks of Pekin type (in Polish). Rocz. AR Poznań 330: 231-240
[31] Woloszyn, J. 2002. The physicochemical and technological characteristic of muscles from force fed ducks (in Polish). Wyd. AE Wrocław, 145.