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# A comparison of three duck strains (Pekin, Muscovy & Sudani) in Egypt for sexual dimorphism with regard to body weight, body measurements and carcass traits

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## Abstract

The Sudani duck (Egyptian Muscovy) is a native bird of Egypt. The objective of this study it compared among Sudani, French Muscovy and Pekin ducks for their sexual dimorphism, live body weight (LBW), body measurements and carcass composition at marketing age (8, 10 and 14 wks) for Pekin, Muscovy and Sudani ducks, respectively. A total of 36 (18 males+ 18 females), 38 (19 males+ 19 females) and 46 (23 males+23 females) for Pekin, Muscovy and Sudani ducks, respectively were investgated. The main results revealed that Pekin ducks had lower sexual dimorphism for live body weight (9.38%) compared to either Sudani (68.47%) or Muscovy (57.95%) ducks. The Muscovy duck strain significantly recorded (p≤0.0001) higher sexual dimorphism for body measurements (44.44%, 38.86%, 22.71% and 23.86% for shank length, keel length, body circumference and body length ,respectively) compared to Pekin ducks, (5.31%, 3.15%, 1.9% and 1.98% for shank length, keel length, body circumference and body length ,respectively) with the Sudani ducks intermediate (35.36%, 20.74%, 22.85% and 24.30% for shank length, keel length, body circumference and body length ,respectively). The Pekin duck exhibited greater (p≤0.05) sexual dimorphism for abdominal fat (18.5%) compared to Sudani (1.08%) and Muscovy (-9.56%) ducks. Sudani ducks significantly recorded greater (p≥0.0001) sexual dimorphism for edible meat parts (90.29%) compared to Pekin (11.83%) ducks, while the Muscovy (58.78%) ducks were intermediate. Finally, The Sudani ducks recorded higher (p≥0.0001) sexual dimorphism for most measurements compared to Pekin ducks; however, the Muscovy ducks were intermediate.

**Keywords: Body weight, Carcass traits, Egyptian Muscovy, Sexual dimorphism, Regression.**

## Introduction

The difference in body weight between males and females, hereafter called sexual dimorphism is particularly marked in poultry. For example, Muscovy male ducks are 40 % heavier than females at slaughtering age, (Mignon-Grasteau *et al.,* 1998). These sex associated differences have been reported in previous studies on Muscovy ducks (Baeza et al., 2001; Teguia *et al.,* 2008; Yakubu *et al.,* 2009a, b). The dimorphism might be attributed to the usual association between sex hormones and growth as reported by Deeb and Cahaner (2001). Baeza *et al.* (1998) submitted that the degree of divergence between sexes may differ; where there was selection for increased body weight, the drakes may reach twice the size of the female. Sexual dimorphism in Muscovy ducks has been reported by several authors (Baeza *et al.,* 2001; Yakubu, 2009a, b; Ogah *et al.,* 2009). Attempts have also been carried out in assessing size and shape in Muscovy duck using principal component analysis (Ogah *et al.,* 2009). Galal *et al.* (2011) reported that the Sudani strain (51.85 %) has a greater dimorphism in body size followed by Muscovy (43.7%) ducks. Male and female Pekin ducks grow and develop differently (Abdel- Samie and Farrell, 1986), with males reported to be heavier than females. This experiment was designed to compare some phenotypic and carcass parameters of Sudani, Muscovy and Pekin duck strains.

## Materials and Methods

This experiment was carried out at a private farm in Fayoum Governorate. A total of 400 (150 Sudani, 125 Muscovy and 125 Pekin) one day old un-sexed ducks were used. They were reared under similar environmental, managerial and hygienic conditions

in the same house from one day old till the end of the experiment. The feed and water were supplied *Ad libtium* . A diet containing 22 % protein and 2900 kcal MEn/kg was feed to Pekin strain (0-2 wk) while Sudani and Muscovy (0-4 wk). A diet containing 16% protein and 3000 kcal MEn/kg was feed to Pekin strain from 2 - 8 wk, while a diet containing 20 % protein and 2900 kcal MEn/kg was feed to Sudani and Muscovy from to 4 wk to the marketing age. Up until marketing age, (8, 10 and 14 wks) for Pekin, Muscovy and Sudani ducks respectively, a total of 36 (18 males+ 18 females), 38 (19 males+ 19 females) and 46 (23 males+23 females) for Sudani, Muscovy and Pekin, ducks respectively, were reared with males and females being together reared but in different pens and with different diets. This house was divided into sex partition. Body weight, body measurements and carcass composition were determined at the marketing age for each strain.

*Body measurements:* These measurements included shank length (SL from the top of hock joint to the foot pad), keel length (KL the keel bone length supporting the breast fillet) were measured with a digital caliper, body circumference (BC taken under the wings at the edge of the sternum and body) length (BL longitude body beginning from beak to termination bird foot) were measured by a measuring tape.

*Carcass measurements:* When the ducklings attained marketing age, 16 birds (8 males + 8 females) from each strain, were randomly taken and slaughtered for carcass evaluation to calculate non-edible meat parts (blood -feathers – head- leg) and edible meat parts (dressed carcass – gizzard-liver - heart ). The abdominal fat, gizzard fat and skin were removed and weighed. The wings and neck were removed and weighed. The carcass, thigh, drumstick and breast muscles (minor and major) were weighed. The bursa of Fabricius and spleen were removed and weighed to the nearest milligram.

**Sexual dimorphism:** Sexual dimorphism (Sx) was calculated for live body weight and body measurements at the marketing age according to the equation of Smith, (1999) using the following equation:

Sexual dimorphism = (male value- female value) / female) X 100 or (Male value/ female value) - 1) X 100. This gives the percentage by which males differ from females, so that **positive** values ( > 0) mean that male is greater than the female for that trait, a **zero** value means males and females are equal, and **negative** values (<0) mean that female is greater than the male for that trait

**Pairs number:** Number of pairs used to calculate the sexual diamorphism and regression analysis of body measurements. The number of pairs were 15, 15 and 16 for Sudani, Muscovy and Pekin, respectively, but eight pairs were used to calculate the carcass parameters in each strain. For the live body weigh the number of males and females was 18, 19 and 26 pairs for Sudani, Muscovy and Pekin, respectively.

**Statistical analysis:** Data were subjected to a one-way Analysis of variance for strain effect using General Linear Model (GLM) procedure of SAS (2001). According to the following model (I); $Yij= \mu + Si+ eij$

Where; Yij= Trait measured, $\mu$ = Overall means, Si = Strain effect, eij = Experimental error

When significant differences among means were found, means were separated using Duncan's multiple range tests.

**Regression analysis:** Simple regression analysis was used to explore relationship between variables using SPSS for windows 18.0. The general expression of simple regression model formed for the measurements, one dependent and independent variables is given as

$Y = bo+ b1 X1$

Where

B0= the intercept parameter, B1= the slope parameter

Y = the dependent variable or Sexual dimorphism (Sx)value for live body weight, body measurements (Sx LBW, Sx SL, Sx KL, Sx BL and Sx BC ), carcass traits ( Sx Non-edible meat parts , Sx Dressed carcass , Sx giblets , Sx Edible-meat parts ,Sx Breast muscles , Sx Thigh, Sx Drumstick, Sx Neck, Sx Wings, Sx Skin, Sx Gizzard fat and Sx Abdominal fat) and Lymphoid organs ( Sx Spleen and Sx Bursa)

X= independent variables or predictors of live body weight for males (LBW M ) and Females (LBW F).

## Results and Discussion

**Sexual dimorphism**: Data presented in Table (1) indicate the absolute and difference between male and female for live body weight, body measurements and carcass traits of duck strains at marketing age. Pekin ducks, also the sexual dimorphism for live body weight, body measurements and carcass parameters is presented in Table (2). Pekin ducks significantly showed less sexual dimorphism for live body weight (LBW) compared to either Sudani or Muscovy ducks. The Pekin duck significantly had lower body circumference and body length compared to the remaining strains. Sexual dimorphism for non-edible parts in Sudani ducks (84.46%) was significantly

higher compared to Pekin (8.14 %) or the Muscovy ducks (67.38 %). The later strain was intermediate and the same trend was noticed for edible meat parts. With respect to sexual dimorphism for breast muscles, thigh and drumstick, Pekin ducks were significantly lowest compared to Sudani and Muscovy ducks. Data in table 2 reveal that Sudani and Muscovy males had a superior breast, thigh and drumstick weight than females. This was not noticed for Pekin ducks. The Pekin ducks exhibited higher dimorphism for abdominal fat compared to Sudani and Muscovy ducks. The Sudani and Muscovy ducks significantly recorded higher sexual dimorphism for skin, wings and neck compared to Pekin duck. Sexual dimorphism for the spleen and bursa in Sudani ducks was significantly higher followed by Muscovy and Pekin ducks.

**Regression:** Linear regression analysis was performed on data set based on both sexes linear regression analysis (Table 3). This was done to analyses the data set to find out the interrelationship magnitude among the independent variables (LBW of the males and females) and dependent variables (sexual dimorphism values for LBW, body measurements and some carcass traits). The intercept, slope, standard error (SE) and P value (P value for the difference of the slope from zero) for both sexes in each strain are presented in Table 3. LBW, keel length, breast muscles and thigh muscles were found to be insignificant for the Sudani males (Table 3). Also, LBW, body measurements, edible meat parts, and drumstick were insignificant for the Muscovy males, similarly, shank length, keel length, body circumference and breast muscles were not significant in the Pekin males. The Sudani females had significant values for all traits except shank length, keel length and drumstick, while, the Muscovy females had significant values for all traits except body measurements and edible meat traits, however, the Pekin females were not significant for all traits except for , LBW and drumstick.

From Table 3 we can observe the relationship between body weight and regression slope where it takes a positive value for both Sudani and Muscovy males, however, the females and Pekin males reordered negative values. This relationship may be related to the higher body weight of the Sudani and Muscovy males and lower body weigh in the females and Pekin male, as shown in table 2, where the difference between males and females (sexual dimorphism) was higher( 69.6% and 57.7 % ) in Sudani and Muscovy respectively compared to the lower value (13.5% ) in Pekin ducks.

Rather than using a blanket statement at the end of the Materials and Methods section, *P* values should be cited at the appropriate places in the Results, i.e. wherever mention is made of significant results. Please note that we use *P*, not p, P or *p*. Likewise, $R^2$ should be written as $R^2$ and r as *r*. For Crops & Soils papers, please use *P* levels of <0.001, <0.01 and < 0.05. For Animals papers, exact *P* values should be quoted, to three decimal places, except for *P* < 0.001. Hong et al. (2012) and Kim et al. (2012) reported that the body weight of Korena male and female native ducks were similar until 7 wk-old but differed from 8 wk-old. With respect to shank length, the Muscovy duck had higher sexual dimorphism for shank length compared either to Sudani or Pekin ducks and a similar trend was noticed for keel length one. Bochno et al., (1994) also reported that male ducks grew faster with more efficient feed conversion than females. The Muscovy drake is almost twice the size of the female, while, in the Pekin duck, the difference is small (3-5%) (Sauveur, 1990). El-Gendy and El- Full (1999) demonstrated that Muscovy duck males had longer shank length until 8 weeks of age than females. Keel length was 12.34 cm in males and 12.26 cm in females in Pekin duckling at 8 weeks of age (El-Sayed, 1979).

Male of Muscovy ducks were 40 % heavier than females at slaughtering age, and 65 % heavier when adults (Mignon-Grasteau et al., 1998). The body composition of males and females also differs considerably (Lukaszewicz et al., 2011). Female Pekin duck had approximately 2 % more carcass fat than males at 6 and 10 wk, and that difference became negligible at 16 wk of age (Abdel-Samie and Farrell, 1986).

Regression analysis has been used to interpret the complex relationship among traits of a number of animals (Akar et al., 2001; Cankaya et al., 2006). Because of the size dimorphism between the male and female. Ogah et al. (2009) found that, body length, bill length, bill height, neck length and head width were found to be insignificant for Muscovy males. This trend was also observed for females wgere, body length, bill length, bill height, shank length and chest circumference were not significant.

**Table.1. live body weight, body measurements, Absolute carcass traits (Means ± SE) at marketing age 8 10 and 14 wks for Pekin, Muscovy and Sudani duck**

| Traits | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Sudani | Muscovy | Pekin | Sudani | Muscovy | Pekin |
| | live body weight and body measurements | | | | | |
| LBW (g) | 3069.4±25 | 4046±86 | 2599.7±43 | 1848±48 | 2608±69 | 2350±40 |
| SL (cm) | 8.2±0.13 | 8.81±0.14 | 6.9±0.13 | 6.0±0.07 | 6.08±0.10 | 6.5±0.11 |
| KL (cm) | 13.07±0.14 | 13.99±0.3 | 10±0.16 | 10.9±0.13 | 9.91±0.18 | 9.7±0.15 |
| BC (cm) | 43.6±0.42 | 45.39±0.7 | 33.2±0.47 | 35.5±0.21 | 36.65±0.6 | 32.6±0.39 |
| BL (cm) | 81.5±1.4 | 86.35±0.4 | 75.4±0.96 | 65.5±0.26 | 70.35±1.8 | 74.63±0.77 |
| | Carcass Traits (g) | | | | | |
| LBW (g) | 2993±64 | 3801±90 | 2282±120 | 1678±101 | 2439±118 | 2034±43 |
| Non-edible meat | 546±18 | 708±60 | 412±16.3 | 296±18 | 423±43 | 381±19 |
| Dressed | 2091±43 | 2716±73 | 1550±98.7 | 1117±74 | 1526±79 | 1380±37 |
| Giblets | 169±8 | 190±6 | 140±18 | 92.8±6 | 126±8 | 124.8±11 |
| Edible meat | 2260±45 | 2831±75 | 1690±104 | 1209±78 | 1751±85 | 1504.3±395 |
| Breast | 440.50±15 | 657±38.6 | 194.8±20 | 210.3±22 | 314±38 | 193.5±13 |
| Thigh | 131.8±11 | 158.5±5 | 158.9±19 | 76.8±8 | 146.3±12 | 169.3±8 |
| Drumstick | 214±8 | 260±16 | 199±19 | 138.8±14 | 186±29 | 153.7±12 |
| Neck | 129±8 | 135±8 | 108.6±3 | 64.3±5 | 82.5±6 | 107.5±8 |
| Wings | 257.2±5 | 390±13 | 156±3 | 128±6 | 255±12 | 166±6 |
| Skin | 226.6±11 | 302±22 | 253±22 | 132±11 | 194±12 | 246.8±19 |
| Gizzard fat | 1.4±0.94 | 8.38±2 | 3.1±6 | 5.8±2 | 10.8±2 | 4±0.68 |
| Abdominal fat | 23.5±5 | 29.8±5 | 30.6±4 | 21.8±4.3 | 35.4±3 | 26.9±2 |
| Bursa | 6.5±0.55 | 4.8±0.74 | 1.98±0.23 | 2.6±0.26 | 3.2±0.39 | 2.03±0.19 |
| Spleen | 2.4±0.28 | 2.9±0.60 | 1.4±0.22 | 1.7±0.1 | 2±0.14 | 1.2±0.12 |

Strain effect and Sex effect (p valye) ≤ 0.0001

LBW= live body weight, SL= shank length, KL= keel length, BC= body circumference and BL= body length.

**Table. 2. Sexual dimorphism (relative value) for live body weight, body measurements and carcass traits (Means ± SE) at marketing age 8, 10 and 14 wks**

| Traits | Strains | | | Strain effect (P value) |
|---|---|---|---|---|
| | Sudani | Muscovy | Pekin | |
| live body weight and body measurements | | | | |
| $SX_{LBW}$ | 69.61a±2.82 | 57.68a±5.93 | 13.53b±1.14 | 0.0001 |
| $SX_{SL}$ | 35.36b±0.7 | 44.44a±0.71 | 5.31c±1.8 | 0.0001 |
| $SX_{KL}$ | 20.74b±0.35 | 38.86a±1.70 | 3.15c±0.45 | 0.0001 |
| $SX_{BC}$ | 22.85a±1.90 | 22.71a±0.73 | 1.90b±0.68 | 0.0001 |
| $SX_{BL}$ | 24.30a±1.71 | 23.86a±1.55 | 1.98b±0.36 | 0.0001 |
| Carcass Traits | | | | |
| $SX_{Non\text{-}edible\ meat}$ | 86.81a±12.48 | 56.39b±5.95 | 7.99c±12.58 | 0.0001 |
| $SX_{Dressed}$ | 88.64a±12.9 | 51.02b±4.39 | 12.94c±1.34 | 0.0001 |
| $SX_{Giblets}$ | 92.72a±17.99 | 57.43b±3.92 | 12.59c±4.55 | 0.0001 |
| $SX_{Edible\ meat}$ | 90.29a±8.83 | 58.78b±2.56 | 11.83c±4.17 | 0.0001 |
| $SX_{Breast}$ | 116.65a±11.51 | 129.09a±18.62 | -0.14b±4.34 | 0.0001 |
| $SX_{Thigh}$ | 74.27a±5.65 | 4.1ab ±3.07 | -8.04b±10.29 | 0.05 |
| $SX_{Drum}$ | 61.35a±11.45 | 74.39 a±4.16 | 26.79b±5.58 | 0.00001 |
| $SX_{Neck}$ | 112.73a±6.89 | 59.21ab±3.66 | 14.8 b±4.13 | 0.00001 |
| $SX_{Wings}$ | 100.1a±8.06 | 48.85b±5.18 | -3.99c±5.18 | 0.0001 |
| $SX_{Skin}$ | 80.91a±7.03 | 27.00ab±4.61 | 6.79b±2.89 | 0.001 |
| $SX_{Gizzard\ fat}$ | -86.85c±3.7 | -8.9a±18.13 | -21.23b±22.28 | 0.05 |
| $SX_{Abdominal\ fat}$ | 16.75b±12.96 | -9.65b±10.21 | 18.50a±6.03 | 0.05 |
| $SX_{Bursa}$ | 153.35a±13.57 | 52.0a±11.03 | -2.23b±12.70 | 0.0001 |
| $SX_{Spleen}$ | 43.57a±16.36 | 39.21a± 19.80 | 21.09b±7.33 | 0.0001 |

[a,b]Means within the same row with uncommon superscript differ significantly (P<0.0001).

LBW= live body weight, SL= shank length, KL= keel length, BC= body circumference and BL= body length.

***Sexual dimorphism** = ((Male value/ female value) - 1) X 100

Thus, **positive values** ( > 0) mean the male is greater than the female for that trait, a **zero value** means males and females are equal, and **negative values** (<0) mean the female is greater than the male for that trait

Table 3. Regression analysis for sexual dimorphism (Sx) values (Y) against live body weigh males ($LBW_m$) (X) and females $LBW_F$ (X) in Sudani, Muscovy and Pekin ducks

| Traits (Y) | $LBW_M$ (X) | | | $LBW_F$ (X) | | |
|---|---|---|---|---|---|---|
| | Sudani ducks | | | | | |
| | Intercept | Slope ± SE | p- value | Intercept | Slope ± SE | p- value |
| $SX_{LBW}$ | 45.28 | 0.007± 0.026 | 0.527 | 225.91 | -0.087 ± 0.002 | 0.0001 |
| $SX_{SL}$ | -3.58 | 0.013± 0.004 | 0.003 | 22.42 | 0.007 ± 0.004 | 0.099 |
| $SX_{KL}$ | 31.65 | -0.004± 0.002 | 1.33 | 26.33 | -0.003 ± 0.002 | 0.137 |
| $SX_{BC}$ | -8.62 | 0.010± 0.003 | 0.002 | 2.21 | 0.011 ± 0.001 | 0.0001 |
| $SX_{BL}$ | -84.56 | 0.036± 0.007 | 0.0001 | -43.38 | 0.037 ± 0.003 | 0.0001 |
| $SX_{Edible\ meat}$ | 336.92 | -0.559± 0.63 | 0.0001 | 154.99 | -0.306 ± 0.122 | 0.034 |
| $SX_{Breast}$ | 349.53 | -0.527± 0.221 | 0.06 | 226.75 | -0.519 ± 0.051 | 0.0001 |
| $SX_{Thigh}$ | 171.50 | -0.220± 0.122 | 0.122 | 117.08 | -0.202 ± 0.068 | 0.025 |
| $SX_{Drumstick}$ | 360.53 | -0.677± 0.134 | 0.002 | 135.68 | -0.349 ± 0.164 | 0.07 |
| | Muscovy ducks | | | | | |
| $SX_{LBW}$ | 22.23 | 0.009± 0.012 | 0.460 | 208.66 | -0.058 ± 0.002 | 0.0001 |
| $SX_{SL}$ | 32.2 | 0.002± 0.002 | 0.268 | 47.64 | -0.002 ± 0.003 | 0.395 |
| $SX_{KL}$ | 57.80 | -0.005± 0.004 | 0.273 | 37.78 | 0.0001 ± 0.006 | 0.972 |
| $SX_{BC}$ | 31.04 | -0.002± 0.002 | 0.329 | 26.80 | -0.002 ± 0.003 | 0.528 |
| $SX_{BL}$ | 55.40 | -0.008± 0.005 | 0.111 | 6.28 | 0.006 ± 0.007 | 0.402 |
| $SX_{Edible\ meat}$ | 9.54 | 0.013± 0.012 | 0.321 | 57.87 | 0.0001 ± 0.018 | 0.983 |
| $SX_{Breast}$ | 696.01 | -0.152± 0.037 | 0.007 | 587.21 | -0.196 ± 0.072 | 0.035 |
| $SX_{Thigh}$ | 114.63 | -0.031± 0.005 | 0.001 | 106.52 | -0.046 ± 0.008 | 0.001 |
| $SX_{Drumstick}$ | 88.03 | -0.004± 0.016 | 0.828 | 144.12 | -0.030 ± 0.021 | 0.201 |
| | Pekin ducks | | | | | |
| $SX_{LBW}$ | 134.95 | -0.048± 0.004 | 0.0001 | 111.1 | -0.042 ± 0.004 | 0.0001 |
| $SX_{SL}$ | -30.92 | 0.15± 0.020 | 0.458 | 0.72 | 0.002 ± 0.007 | 0.777 |
| $SX_{KL}$ | -13.56 | 0.006± 0.008 | 0.51 | -1.98 | 0.001 ± 0.003 | 0.815 |
| $SX_{BC}$ | -26.34 | 0.12± 0.012 | 0.349 | -16.93 | 0.008 ± 0.004 | 0.06 |
| $SX_{BL}$ | -43.04 | 0.18± 0.004 | 0.001 | -11.06 | 0.005 ± 0.002 | 0.19 |
| $SX_{Edible\ meat}$ | -62.89 | 0.033± 0.005 | 0.0001 | -105.96 | 0.58 ± 0.032 | 0.124 |
| $SX_{Breast}$ | -57.39 | 0.025± 0.011 | 0.06 | -31.92 | 0.016 ± 0.041 | 0.717 |
| $SX_{Thigh}$ | -146.92 | 0.062± 0.024 | 0.044 | -150.09 | 0.071 ± 0.094 | 0.481 |
| $SX_{Drumstick}$ | -154.15 | 0.084± 0.026 | 0.025 | -199.81 | 0.113 ± 0.031 | 0.015 |

P value for the difference of the slope from zero

.X= independent variables or predictors absolute live body weight for males ($LBW_M$) or females ($LBW_F$)

Y = the dependent variable of Sexual dimorphism value (SX)

$SX_{LBW}$= Sexual dimorphism for live body weight, $SX_{SL}$= Sexual dimorphism for shank length, $SX_{KL}$= Sexual dimorphism for keel length, $SX_{BC}$= Sexual dimorphism for body circumference, $SX_{BL}$= body length, $SX_{Edible\ meat}$ = . Sexual dimorphism fo edible meat parts, $SX_{Breast}$ =Sexual dimorphism fo breast muscle

## Conclusion

Finally we concluded that the Sudani duck significantly had higher sexual dimorphism for most of traits compared to Pekin ducks; however, the Muscovy ducks were intermediate. Also we can conclude that the females in all strains and the Pekin males had significant values for sexual dimorphism live body weight (dependent variable) against live body weight (independent variable). Most of traits in males and females of Sudani ducks were significant compared to Pekin and Muscovy ducks. The regression analysis made during this study indicated that live body weight can be used as a good indicator for predicting sexual dimorphism for some traits of

body measurements and carcass traits in males and females in each strain.

## Conflicts of Interest

There are no conflicts of interest.

## Ethical Standards

Animal care and maintenance were performed in accordance with guidelines of Egyptian Research Ethics Committee and the guidelines contained in the Guide for the Care and Use of Laboratory Animals (2011).

## References

Abdel-Samie, R.E and Farrell, J.D. (1986). Carcass composition and carcass characteristics of ducks. Duck Production Science and World Practice (Farrell and Stapleton, Eds.).University of New England, Amidale, Australia 83-101

Akar, M, Sangun, L, Baylan, M. (2001). A study about some quantitative traits of species of Serranushepatus X1 Aquaculture symposium, Hatay, Turkey 1: 366-367.

Baeza, E, Salichon. M.R, March, G, Juin, H. (1998). Effect of sex on growth, technological and organoleptic characteristics of the Muscovy duck breast muscle. British Poultry. Science. 39, 389-403.

Baeza E, Williams J, Guémené D, Duclos M. J. (2001). Sexual dimorphism for growth in Muscovy ducks and changes in insulin-like growth factor I (IGF-I), growth hormone (GH) and triiodothyronine (T3) plasma levels, Reproduction Nutrition Development, EDP Sciences. 41, 173-179.

Bochno, R, Lewczuk, A, Wawko, E. (1994). Comparison of growth and feed conversion efficiency of Muscovy and Pekin ducks, Poultry Abstract Volume 20. Number 3, 18 CAB International.

Cankaya S, kayaalp G.T, Sangun L, Tahtali Y, Akar M. (2006). A comparative study of estimationmethod of parameter in multiple linear regression model . J. Applied. Animal. Research., 29: 43-47.

Deeb, N and Cahaner, A. (2001). Genotype by temperature interaction with broiler genotypes differing in growth rate. 1. The effects of high ambient temperature and naked neck genotype on lines differing in genetic background. Poultry Science 80, 695-702.

El-Gendy, E. A and El-Full E. A. (1999). Breed and sex of duckling growth rate, carcass traits and meat chemical composition and in response to bedding type. Egyptian Poultry Science. 19, 325-349.

El-Sayed T. M (1979). Genetical and nutrition studies on ducks. (A comparison study between the effect of genetic and nutrition on improving some productive traits of Pekin ducklings). M.Sc. Thesis, Fac. of Agriculture. Tanta University, Egypt.

Galal, A, Ali, W. A. H, Ahmed, A. M. H and Ali, Kh. A. (2011). Performance and carcass characteristics of Domyati, Muscovy, Peking and Sudani duck breed. Egyptian. Journal. Animal Production. 48 (2),191-202.

Hong, E.C, Choo, H.J, Kang, B.S, Kim, C.D, Heo, K.N, Lee, M.J, Hwangbo, J, Suh, O.S, Choi, H.C and Kim, H.K. (2012)0. Performance of growing period of large-type Korean native ducks. Korean. Poultry Science 39, 143–149.

Kim, H.K, Kang, B.S, Hwangbo, J, Kim, C.D, Heo, K.N, Choo, H.J, Park, D.S, Suh, O.S and Hong, E.C. (2012). The study on growth performance and carcass yield of meat-type Korean native ducks. Korean. Poultry Science 39, 45–52.

Lukaszewicz, E, Kowalczyk, A, Adamski, M and Kuzniacka J. (2011). Growth parameters and meat quality of Pekin ducks fed on different level of dried distillers grains with solubles. Archive Tierzucht. 54, 557-566.

Mignon-Grasteau, S, Beaumont, C, Paul, J and Rochambeau, H. (1998). Estimation of the genetic parameters of sexual dimorphism of body weight in 'label' chickens and Muscovy ducks. Genetic Selection Evolyation 30, 481 - 491.

Neter, J, Wasserman, W and Kutner, M.H. (1989). Applied linear statistical models 2nd Edn Boston M A incpp: 667.

Ogah, D.M, Alaga, A.A and Momoh, M.O (2009). Principal component factor analysis of the morph structural traits of Muscovy duck. International Journal of Poultry Science 8 (11), 1100-1103.

Sauveur, B. (1990). Origines et performances comparées du canard de Barbarie et du canard commun de race Pékin. In: Sauveur B, de Carville H (eds.) Le Canard de Barbarie, INRA, Paris, France, 3-11 [in French].

Smith R J. (1999) *Statistics of sexual size dimorphism*. Journal of Human Evolution 36, 423–459.

Teguia, A, Mafouo, H, Ngandjou, H.D and Tchoumboue, J. (2008). Study of the live body weight and body characteristics of the African Muscovy duck (*Carina moschata*). Tropical. Animal Health. Production. 40 (1), 5-10.

Yakubu, A, Idahor, K.O and Agade, Y.I. (2009b). Using factor scores in multiple linear regression models for predicting the carcass weight of broiler chickens using body measurements. Revista Científica UDO Agricola 9 (4), 963-967.

Yakubu, A, Kuje, D and Okpeku, M. (2009a). Principal components as measure of size and shape in Nigerian indigenous chickens. Thai Journa of Agricultural. Science 42 (3), 167-176.