THE EFFECT OF SEX AND GROWING PHASES ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF LOCAL MUSCOVY DUCKS *(CAIRINA MOSCHATA)*

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ABSTRACT

The experiment was a 2x3 factorial design. The first factor was the duck's growing periods with split phases (5-8 weeks old and 9-12 weeks old) and whole phase (5-12 weeks old). The second factor was the sex of birds, with three treatments, male birds, female birds and balanced for sex. The results showed that male local Muscovy ducks had the highest weight gain, body live weight and economic efficiency. Ducks with split phase (5-8 weeks old and 9-12 weeks old) gave a better result in weight gain, carcass traits and economic efficiency than the ducks raised in entire phase (5-12 weeks old).

Keywords: *Duck phases, sex, performance, carcass, Muscovy duck.*

INTRODUCTION

Muscovy ducks (*Cairina moschata*) are a native duck to Middle and South of the Americas (Anonymou, 2012). To ensure the growth performance of Muscovy ducks, farmers have to provide a suitable and sufficient amount of nutrients for them following their growing phases. Crude protein (CP), amino acids and energy play a crucial role in Muscovy duck nutrition; therefore, CP and amino acids are currently of concern to scientists (Linares et al., 2012; Baeza et al., 2012 và Zhang et al., 2014). Kamran et al. (2004) recorded that CP is one of the most important components in poultry diets and that ingredients that contain protein have a high price (Ojano-Dirain and Waldroup, 2002).

Providing suitable amounts of protein and amino acids for ducks, according to age, in the diet of ducks can both improve carcass performance, reduce feed costs, improve economic efficiency, and at the same time reduce nitrogen excretion that causes pollution (Moran, 1992; Ospina-Roja, 2012). In addition, an appropriate level of metabolizable energy with the lysine content in the diet will be an important factor affecting carcass performance and quality (Eits et al., 2002; Collin et al., 2003; Purba et al., 2016). Muscovy ducks are sexually dimorphic; male Muscovy ducks have a higher growth performance than female ducks, and their body weight is 50% heavier than that of females at the finisher phase (Larbier and Leclercq, 1994; Baeza et al., 1998). Female Muscovy ducks reach maturity (at 10 weeks of age), which is earlier than males (at 12 weeks of age) (Larbier and Leclercq, 1994; Baeza et al., 1998; Bui Xuen Men, 1996; Nguyen Thi Kim Dong and Ogle, 2003). From previous studies, Nguyen Thuy Linh et al. (2017) determined a diet with 19% CP and 12.97 MJ ME/kg DM for 5-8 weeks of age and 17% CP and 13.81 MJ ME/kg DM for 9-12 weeks of age gave the best performance in daily weight gain, body weight, feed conversion ratio and carcass quality. According to the study of Tolimir et al. (2013), feed formulated by growing phases had a positive effect on the growth and development of poultry, especially increasing economic efficiency in broilers. In addition, Tolimir et al. (2013) also said that the use of feed according to growing phases had a positive effect on the performance of male birds and did not have any negative effects on bird performance.

However, studies on Muscovy ducks in this area, as well as published results, are very limited. The objective of the study was to determine the effect of growing phases and sex on feed consumption, weight gain, feed efficiency and carcass traits of Muscovy ducks.

METHODS AND MATERIALS

Location and time

The study was conducted from August 2019 to December 2019 at the experimental farm of Tra Vinh University and the laboratory of the Department of Animal Science, Faculty of Agriculture, Can Tho University.

Animals and Experimental Materials

The local Muscovy ducks (Trau) used in the experiment were purchased at the local Muscovy duck farm in Duc My commune, Cang Long district, Tra Vinh Province. Experimental ducks were raised from 1 day old to 28 days old before starting the experiment and vaccinated with hepatitis antibodies, cholera and H5N1 vaccines. Ducks were allotted to the experiment at the beginning of the 5th week of age and the beginning of the 9th week of age.

Housing

Local Muscovy ducks were raised on the floor, which was covered by husks with Balasa Bioyeast. Each cage was used for a replicate made from iron nets with an area of 4.8 m^2 (1.2 m x 4 m). A total of 10 birds were allotted in one replicate.

Feeding

The feed from this experiment was in powder form. The ingredients used in the diet were corn, broken rice, rice bran, fish meal, soybean seed, dicalcium phosphate and mineral-premix and vitamin. After making feed, one sample was taken to check feed compositions at Can Tho University and Institute of Animal Science at Ha Noi.

Experimental design

The experiment was a 2x3 factorial design with a total of 180 local Muscovy ducks. The first factor was growing phases, including split phases (5-8 weeks old and 9-12 weeks old) and the whole phase (5-12 weeks old). The second factor was the sex of birds, with three treatments, male birds, female birds and balanced for sex. Each replicate included 10 local Muscovy ducks (10 males, 10 females and 5 males + 5 females). The chemical composition of the ingredients is shown in Tables 1 and 2.

Table 1. Chemical compositions of all ingredients used in the experiment (% DM)

Criteria (%)	Corn	Rice bran	Broken rice	Fish meal	Soybean	DCP	Premix	Threonine	Lysine	Methionine
DM	87.9	88.3	86.9	91.6	93.7	100	100	99.9	97.4	99.3
OM	98.8	90.9	99.1	79.3	95.3	14.8	-	-	-	-
CP	8.85	12.8	8.35	60.7	43.4	-	-	-	-	-
EE	3.87	10.6	2.46	9.03	18.3	-	-	-	-	-
NFE	82.6	60.7	86.6	8.50	24.7	-	-	-	-	-
CF	3.51	6.82	1.74	1.10	8.90	-	-	-	-	-

Criteria (%)	Corn	Rice bran	Broken rice	Fish meal	Soybean	DCP	Premix	Threonine	Lysine	Methionine
NDF	19.8	24.6	5.03	7.78	18.3	-	-	-	-	-
ADF	3.87	11.0	1.46	1.54	11.2	-	-	-	-	-
Ash	1.24	9.12	0.92	20.7	4.75	-	-	-	-	-
Lysine	0.32	0.51	0.35	3.97	2.22	-	-	-	74.5	-
Methionine	0.18	0.25	0.19	1.38	0.62	-	-	-	-	87.1
Threonine	0.27	0.51	0.34	2.33	1.41	-	-	97.9	-	-
Ca	0.17	0.31	0.21	6.01	0.67	23.5	-	-	-	-
Total P	0.30	1.42	0.25	2.62	0.64	18.6	-	-	-	-
ME (MJ/kg)	15.6	11.3	14.2	12.4	14.7	-	-	-	-	-

Note: Dry matter (DM), organic compounds (OM), crude protein (CP), crude fat (EE), crude fiber (CF), total minerals (Ash), DCP: dicalcium phosphate, ME: MJ/kg DM

The feed composition and chemical composition of the diet are shown in Table 2. The amount of CP and ME in the diet of 2 growing phases (5-8; 9-12 weeks of age) were applied from the results of Linh et al. (2017)

Table 2. Diet composition of the experiment of local Muscovy ducks from 5-8; 9-12 weeks old and 5-12 weeks old (% DM)

Ingredients (%)	5-8 weeks old			9-12 weeks old			5-12 weeks old		
	Male	***Female***	***Both***	***Male***	***Female***	***Both***	***Male***	***Female***	***Both***
Corn	16.5	16.5	16.5	37.1	37.1	37.1	27.0	27.0	27.0
Rice bran	40.3	40.3	40.3	22.7	22.7	22.7	31.62	31.62	31.62
Broken rice	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Fish meal	9.00	9.00	9.00	7.20	7.20	7.20	8.30	8.30	8.30
Soybean	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0
Mineral premix-Vitamin	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.20	0.20	0.20	0.24	0.24	0.24
Methionine	-	-	-	-	-	-	-	-	-
Threonine	0.10	0.10	0.10	-	-	-	0.04	0.04	0.04
DCP	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100	100	100	100	100

Ingredients (%)	5-8 weeks old			9-12 weeks old			5-12 weeks old		
	Male	***Female***	***Both***	***Male***	***Female***	***Both***	***Male***	***Female***	***Both***
DM	89.0	89.0	89.0	88.7	88.7	88.7	88.8	88.8	88.8
OM	92.3	92.3	92.3	94.2	94.2	94.2	93.2	93.2	93.2
CP	19.0	19.0	19.0	17.0	17.0	17.0	18.0	18.0	18.0
EE	8.36	8.36	8.36	6.95	6.95	6.95	7.60	7.60	7.60
NFE	60.0	60.0	60.0	65.9	65.9	65.9	63.1	63.1	63.1
CF	4.81	4.81	4.81	4.23	4.23	4.23	4.49	4.49	4.49
NDF	17.0	17.0	17.0	16.4	16.4	16.4	17.0	17.0	17.0
ADF	6.79	6.79	6.79	5.52	5.52	5.52	6.12	6.12	6.12
Ash	7.00	7.00	7.00	5.23	5.23	5.23	6.15	6.15	6.15
Lysine	1.20	1.20	1.20	1.00	1.00	1.00	1.09	1.09	1.09
Methionine	0.37	0.37	0.37	0.33	0.33	0.33	0.35	0.35	0.35
Threonine	0.81	0.81	0.81	0.61	0.61	0.61	0.70	0.70	0.70
Ca	0.96	0.96	0.96	0.83	0.83	0.83	0.90	0.90	0.90
P	1.09	1.09	1.09	0.85	0.85	0.85	0.98	0.98	0.98
ME (MJ/kg)	12.97	12.97	12.97	13.82	13.82	13.82	13.39	13.39	13.39

Chemical analysis

Chemical composition of feed: dry matter (DM), organic compounds (OM), crude protein (CP), crude fat (EE), crude fiber (CF), total minerals (Ash), calcium and phosphorus were analysed according to AOAC (1990), and neutral fiber (NDF) and acid fiber (ADF) were analysed according to Van Soest et al. (1991). The content of amino acids present in the raw materials was analysed by the AOAC method (AOAC, 1990). The ME value of feed ingredients was estimated according to the suggestion of Janssen (1989) cited from NRC (1994).

Data collection

Experimental ducks were fed 3 times/day (7 am, 13 pm and 17 pm). The feeders and drinkers were arranged separately in each cage. Leftovers were collected and weighed the next morning to calculate daily feed intake. Ducks are provided with adequate drinking water around the clock.

The amount of feed and nutrients consumed, body mass gain, weight at the end of the experiment in both phases and economic efficiency of the experiment were recorded. Carcass traits of local Muscovy ducks were performed from 4 ducks (including 2 males and 2 females for the treatment with males and females; 4 males for the treatment of only males; 4 females for the treatment of only female ducks) in each replicate at the end of the experiment. The evaluation of carcass traits was performed according to the method of Auaas and Wilke (1978).

Data analysis

The data were preliminarily processed by Microsoft Excel (2013) and analysed by statistical analysis of variance (ANOVA) using Minitab 16.1.0 software (2010) (two factor analysis model). The covariances of the parameters of weight gain, body weight and feed conversion ratio were analysed. Tukey test analysis was used to compare the means of treatments with 95% confidence. Mean values are considered to be significantly different when $P<0.05$.

RESULTS AND DISCUSSION

Proximate analysis of diet in the experiment

Proximate analysis of the diet for local Muscovy ducks is shown in Table 3.

Table 3. Proximate analysis of the diet for local Muscovy ducks from 5-12 weeks old (g, DM/head/day)

Criteria	Sex			Growing phases		SEM/P		
	Male	***Female***	***Both***	***5-8; 9-12 weeks old***	***5-12 weeks old***	***Sex***	***Growing phase***	***Sex * growing phase***
DM	125[a]	78,0[c]	111[b]	98.6	111	2.79/0.001	2.29/0.002	3.96/0.961
OM	117[a]	72.8[c]	104[b]	91.9	104	2.61/0.001	2.13/0.002	3.69/0.961
CP	22.6[a]	14.0[c]	19.9[b]	17.8	19.9	0.50/0.001	0.41/0.003	0.71/0.957
EE	9.57[a]	5.95[c]	8.48[b]	7.55	8.45	0.21/0.001	0.17/0.003	0.30/0.953
NFE	79.1[a]	49.2[c]	70.0[b]	65.2	70.5	1.76/0.001	1.44/0.002	2.49/0.963
CF	5.65[a]	3.51[c]	5.01[b]	4.99	4.46	0.13/0.001	0.10/0.003	0.18/0.954
NDF	20.9[a]	13.0[c]	18.6[b]	16.5	18.6	0.47/0.001	0.38/0.002	0.66/0.960
ADF	7.70[a]	4.78[c]	6.82[b]	6.06	6.80	0.17/0.001	0.14/0.003	0.24/0.955
Ash	7.69[a]	5.14[c]	6.81[b]	6.03	6.83	0.17/0.001	0.14/0.002	0.24/0.965
Lysine	1.37[a]	0.85[c]	1.22[b]	1.08	1.21	0.03/0.001	0.03/0.004	0.04/0.951
Methionine	0.44[a]	0.27[c]	0.39[b]	0.35	0.39	0.01/0.001	0.01/0.002	0.01/0.961
Threonine	0.88[a]	0.55[c]	0.78[b]	0.70	0.78	0.02/0.001	0.02/0.005	0.03/0.945
Ca	1.13[a]	0.70[c]	0.99[b]	0.88	1.00	0.03/0.001	0.02/0.002	0.04/0.965
P in total	1.22[a]	0.76[c]	1.08[b]	0.96	1.09	0.03/0.001	0.02/0.001	0.04/0.968
ME (MJ/head/day)	1.68[a]	1.05[c]	1.49[b]	1.32	1.49	0.04/0.001	0.03/0.002	0.05/0.960

Note: a, b, c: Mean values with different letters in the same column are statistically significant differences at the P<0.05 level.

The results in Table 3 show that following the sex factor, the amount of DM and nutrients consumed by experimental ducks were lower in the female group and higher in the male group (P<0.05). This result was because ducks are sexually dimorphic, and males are heavier than females, leading to higher consumption of DM and nutrients. For the growing phase factor, the amount of DM and nutrients consumed in one raising phase from 5-12 weeks old was significantly higher (P<0.05) than in split phases (5-8; 9-12 weeks old). This result may be because the experimental ducks reared at split phases with 2 diets had higher levels of CP, ME and other nutrients than those raised in one phase from 5 to 12 weeks old. This result is consistent with the results of Men et al. (1996), who studied Muscovy ducks with DM consumption of 125 g/head/day for males and 88 g/head/day for females. In addition, the result of DM consumption for both sexes was similar to the results of Nguyen Thuy Linh et al. (2017), who found that DM and ME consumption was 101 g/head/day and 1.33 MJ ME/head/day, respectively. Additionally, the amount of lysine, methionine and threonine consumed was lowest in the female duck group and highest in the male group (P<0.05). This result can be explained by the higher DM consumption in these treatments.

Growth performance of local Muscovy ducks

Growth performance, including body weight gain, feed intake and feed conversion ratio, is shown in Table 4.

Table 4. Growth performance of local Muscovy ducks

Criteria	Sex			Growing phases		SEM/P		
	Male	***Female***	***Both***	***5-8; 9-12 weeks old***	***5-12 weeks old***	***Sex***	***Growing phase***	***Sex * growing phase***
Initial weight	825[a]	627[c]	745[b]	734	731	5.64/0.001	6.61/0.649	7.98/0.935
Final weight	3285[a]	2047[c]	2662[b]	2699	2629	106/0.001	22.8/0.050	111/0.464
Weight gain	45.6[a]	23.5[c]	34.5[b]	35.1	33.9	1.90/0.001	0.41/0.050	1.99/0.464
FCR	2.97	3.1	3.26	2.86	3.36	0.35/0.150	0.08/0.001	0.37/0.871
CP/weight gain (g/kg)	495[b]	602[a]	582[a]	515	604	16.3/0.001	13.2/0.001	22.8/0.624
PER	2.04[a]	1.68[c]	1.74[b]	1.96	1.68	0.05/0.001	0.04/0.001	0.07/0.960
ME/weight gain (MJ/kg)	36.9[b]	44.8[a]	43.3[a]	38.3	45.0	1.19/0.001	0.98/0.001	1.69/0.620

Note: a, b, c: Mean values with different letters in the same column are statistically significant differences at the P<0.05 level.

Table 4 shows that the weight gain of experimental ducks in the male group was lower than that in the other groups. For the farming method in 2 stages, treatment 5-8; 9-12 weeks old was higher than 5-12 weeks old (P<0.05). Regarding the growing phase factor, ducks in the split phase had a higher weight gain than those 5-12 weeks old. Similarly, the final weights of the experimental ducks were similar to the weight gain results. The final weight was highest in the male group. This result can be explained by the fact that ducks raised in two phases, fed diets with CP and ME levels, are more responsive to their requirements than ducks reared in phase 1 from 5-12 weeks old, resulting in increased weight gain and higher end mass.

The results of weight gain and final weight of experimental ducks were higher than the results of weight gain of 31.7 g/day and final weight of 2,287 g/head in the study of Nguyen Thuy Linh et al. (2017) on local Muscovy ducks fed diets with different levels of lysine and ME. From the results obtained in this experiment, it was shown that applying the best CP and ME levels in the diets of Muscovy ducks at split phases in the previous study of Nguyen Thuy Linh et al. (2017) improved the performance of experimental ducks.

The feed conversion ratio (FCR) was lowest (P<0.05) in the split phases 5-8; 9-12 weeks old (2.86), possibly due to the high weight gain of ducks.

Table 5. Body weight gain, final weight of ducks in growing phases factor (g/bird)

Criteria	**Sex**	**Growing phases**		**SEM/P**
		5-8; 9-12 weeks old	***5-12 weeks old***	
Initial weight	Male	825	825	4.7/0.958
	Female	630	625	8.7/0.683
	Both	747	742	18/0.837
Final weight	Male	3422	3342	28/0.035
	Female	1945	1925	17/0.347
	Both	2734	2615	140/0.544
Weight gain	Male	46.4	44.9	0.49/0.034
	Female	23.5	23.2	0.36/0.529
	Both	35.5	33.4	2.4/0.544

Table 5 shows that the final weight and weight gain of male ducks were significantly higher than those of the other ducks (P<0.05).

Carcass characteristics of local Muscovy ducks

The carcass characteristics of local Muscovy ducks are shown in Table 6.

Table 6 shows that for the sex factor, male ducks had the highest carcass weight, followed by male + female, and the lowest carcass weight was in female ducks (P<0.05). For growing phase factors, carcass weights (1,814 g/head) were higher in the split phase treatment and lower in the 5-12-week-old treatment (1,728 g/head) (P<0.05). This result shows that the carcass weight of Muscovy ducks in both factors corresponds to the weight of the surveyed ducks and has the same trend as the results of increasing weight gain and final weight. Meanwhile, the carcass percentage among the treatments was in the range of 66.2-67.3%, and the difference was not

statistically significant (P>0.05). Breast weight was low in the 5-12-week-old treatment (343 g/head) and high (P<0.05) in the split-phase treatment (386 g/head). However, the breast percentage was not significantly different (P>0.05) between the treatments of both factors. The weight of thigh meat was higher (P<0.05) in the split-phase treatment (305 g/head) than in the 5-12-week-old treatment (263 g/head). The difference between Muscovy ducks and other ducks is that Muscovy ducks are sexually dimorphic, and males have a higher growth rate than female ducks. Therefore, the weight of males at the finisher phase is 50% heavier than that of females, and females reach maturity at 10 weeks of age, which is earlier than males (at 12 weeks of age) (Larbier and Leclercq, 1994; Baeza et al., 1998; Bui Xuan Men, 1996; Nguyen Thi Kim Dong and Ogle, 2003). Linh et al. (2007) showed that local Muscovy ducks had carcass percentage (65.1-66.6%), breast percentage (18.3-20.9%) and thigh percentage (15.4-16.1%), the percentage of both breast and thigh meat (35.3-37.9%).

Table 6. Carcass characteristics of experimental ducks

Criteria	**Sex**		**Growing phases**			**SEM/P**		
	Male	***Female***	***Both***	***5-8; 9-12 weeks old***	***5-12 weeks old***	***Sex***	***Growing phases***	***Sex * Growing phases***
Live weight, g/bird	3.377[a]	1.930[c]	2.664[b]	2.697	2.617	27.9/0.001	22.8/0.030	39.5/0.345
Carcass weight, g	2.228[a]	1.292[c]	1.794[b]	1.814	1.728	33.3/0.001	27.2/0.047	47.1/0.413
Carcass percentage	65.9	66.9	67.3	67.3	66.2	0.48/0.161	0.39/0.079	0.68/0.538
Breast weight, g	426[a]	283[b]	383[a]	386	343	16.4/0.001	13.4/0.044	23.2/0.950
Breast percentage	19.1	21.9	21.3	21.6	20.0	0.99/0.160	0.81/0.194	1.41/0.705
Thigh weight, g	369[a]	200[c]	282[b]	305	263	15.3/0.001	12.5/0.036	21.7/0.982
Thigh percentage	16.7	15.5	15.7	16.8	15.1	0.92/0.632	0.76/0.120	0.76/0.627
Thigh + breast weight, g	795[a]	484[c]	665[b]	690	606	22.9/0.001	18.7/0.008	32.4/0.946
Thigh and breast percentage	35.8	37.4	37.0	38.4	35.1	1.47/0.740	1.20/0.071	2.08/0.516
Abdomen fat weight, g	47,2	29.2	31.4	39.4	32.4	6.72/0.162	5.48/0.388	9.50/0.160
Abdomen fat percentage, %	2.10	2.24	1.71	2.14	1.90	0.37/0.588	0.30/0.594	0.53/0.152
Liver weight, g	60.0	28.8	41.1	42.9	43.6	0.65/0.001	0.53/0.392	0.92/0.811
Gizzard weight, g	84.7	72.3	72.3	72.4	72.5	2.32/0.001	1.89/0.968	3.28/0.954
Heart weight, g	20.5	13.7	17.3	17.1	17.3	0.86/0.001	0.70/0.827	1.21/0.988

Note: a, b, c: Mean values with different letters in the same column are statistically significant differences at the P<0.05 level.

Economic efficiency of local Muscovy ducks

The economic efficiency of local Muscovy ducks is shown in Table 7.

Table 7. Economic efficiency of local Muscovy ducks (VND/head)

Criteria	Sex		Growing phases		
	Male	***Female***	***Both***	***5-8; 9-12 weeks old***	***5-12 weeks old***
Duckling costs	75.000	75.000	75.000	75.000	75.000
Medical costs	5.000	5.000	5.000	5.000	5.000
Feed costs	34.538	21.483	30.602	27.294	30.455
Total costs	114.538	101.483	110.602	107.294	110.455
Total revenue	219.906	125.789	173.853	175.555	170.810
Profit	105.368	24.307	63.251	68.261	60.356

The prices of ingredients and birds were calculated at the time of the experiment.

The analysis of economic efficiency through the treatments showed that total cost was highest in the male group (114,538 VND/head). However, the total revenue from selling ducks at the end of the experiment was the highest (219,906 VND/head) in the male group. This leads to the highest profit in this treatment (105,368 VND/head). For the treatment of growing phases, the total cost is low in the split phases, which is 107,294 VND/head compared to 5-12 weeks old (110,455 VND). This is mainly due to an increase in feed cost. However, for growing phase factors, the total revenue from selling Muscovy ducks at the end of the experiment was high (VND 175,555/head), leading to the highest profits in this treatment (VND 68.261/head).

CONCLUSION

Raising Muscovy ducks according to sex, male Muscovy ducks gave the highest weight gain, body weight and economic efficiency. Muscovy ducks raised in split phases resulted in increased weight, higher carcass quality and good economic efficiency for local Muscovy ducks raised for 5-12 weeks of age.

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