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SELECTION TO CREAT 2 MUSCOVY DUCK LINES FROM MATERIAL RESOURCE OF FRANCE R71 SL MUSCOVY DUCK

Major : Animal genetics and breeding

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BRIEF INFORMATION OF PhD THESIS

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PUBLISHED PAPERS RELATED TO THE THESIS

1. **Ta Thi Huong Giang, Phung Duc Tien, Nguyen Quy Khiem. 2023**. Genetic parameters of some performance traits of NTP1 male muscovy duck reared in Thuy Phuong. Journal of Animal Husbandry Sciences and Technics, No. 284, January 2023, pp. 19-24.

2. **Ta Thi Huong Giang, Phung Duc Tien, Nguyen Quy Khiem, Tran Ngoc Tien, Pham Thi Kim Thanh, Nguyen Thi Tam. 2023**. Results of selection for NTP2 female muscovy duck line in the direction of egg performance, Journal of Animal Husbandry Sciences and Technics, No. 286, March 2023, pages 7-12.

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INTRODUCTION

1. RATIONABLE

In recent years, muscovy duck raising has developed from traditional small-scale farming by household method to gradually turning into large-scale commodity farming. This shows that there is an important impact of science and technology, including breeding work and the increasing market demand for high-performance breeders suitable for industrial raising methods.

The grand-parental R71 SL muscovy duck male and female had a fast growth rate, a large mature body weight, at the end of 24 weeks of age, A male was 5,573g, B: female was 3,080g. The hen line had high egg performance; D female was 114.3 eggs/hen in cycle 1. The egg performance of parental muscovy duck was 114 eggs/hen in cycle 1, embryo rate was 88-90%. Commercial muscovy duck. have a body weight of 5.5 kg at 12 weeks of age, males were 5.5 kg, at 10 weeks of age females was 3.0 kg, feed consumption/kg in body weight gain was 2.8 kg. However, the imported lines were unisexual, after two exploitation cycles, they must be discarded.

In order to exploit genetic resources effectively, limit imports, step by step to take the initiative breed, meet the increasing demand of production for high- performance muscovy duck, adapted to the raising conditions of Vietnam, serve the restructuring of the livestock industry towards increasing added value and sustainable development. It is necessary to conduct the project "selection to create 2 muscovy duck lines from material source of French R71SL muscovy duck ".

2. THE GOAL OF THESIS

- Selected to create NTP1 male lines with high body weight and stable egg performance.

- Selected to create NTP2 female lines with high egg performance and stable body weight

- Evaluated meat production ability of commercial NTP12 crossbred muscovy duck produced between male NTP1 and female NTP2 muscovy duck.

3. SCIENTIFIC AND PRACTICAL VALUE OF THESIS

3.1. Scientific value

- It is a systematic scientific study. The method of individual selection was used according to phenotypic value and selected breeding value to select

successfully NTP1 male line with high body weight and NTP2 female line with high egg performance. The commercial crossbreeding NTP12 muscovy duck had outstanding heterosis in terms of body weight and feed consumption/kg body weight gain.

- The results of the study are valuable references in research, teaching and learning at training institutions and breeding facilities for waterfowl in general and muscovy duck in particular.

3.2. Practical value

- Selected to create 2 NTP1, NTP2 muscovy duck lines and commercial meat NTP12 crossbred with high body weight to meet the requirements of muscovy duck raising on farm and household scale.

- The results of the project contributed to helping domestic livestock establishments to actively produce muscovy ducks with high meat performance to replace part of the imported breeds every year.

4. CONTRIBUTORS OF THESIS

- The selective method was used to create a line using the estimated breeding value. Selection to create 2 muscovy duck lines with outstanding performance. The male NTP1 line had a body weight at 8 weeks of age, the BW of male was 3,408.33g, the BW of female was 2,311.15g, an increase of 9.32-9.34% compared to initial generation. The egg performance of female NTP2 line at 38 weeks of age was 50.29 eggs per hen, an increase of 4.08 eggs compared to initial generation and 111.06 eggs per hen/cycle 1, an increase of 4.95 eggs compared to initial generation.

- From 2 new muscovy duck lines, a commercial crossbreed NTP12 was created with high heterosis in terms of body weight and feed consumption. At 11 weeks of age, the male muscovy duck's body weight was 4,913.01g, the hen's body weight was 2,909.59g and the feed consumption/kg body weight gain was 2.73kg.

CHAPTER 1. LITERATURE REVIEW

1.1. SCIENTIFIC BASIS OF THESIS

The research problem of the thesis is based on the scientific basis of genetic characteristics of quantitative traits, crossbreeding and heterosis, methods of selection for poultry breeds, growth rate and reproductive performance of poultry products.

1.2. RESEARCH SITUATION IN VIETNAM AND INTERNATION

The thesis has evaluated the situation of domestic and foreign research on selection, crossbreeding waterfowl in general and muscovy duck in particular.

On the basis of analysis and evaluation of research results in domestic and abroad, it shows that: for waterfowl breeding, there have been many research works on breeding, using advanced selection methods. but mainly on ducks, on muscovy ducks is still very limited, especially domestic research.

CHAPTER II

OBJECTIVES, CONTENTS AND RESEARCH METHODS

2.1. OBJECTIVES, LOCATION AND PERIOD OF RESEARCH

2.1.1. Objectives

- A male, AB female, C male, CD female, imported R71SL and 2 NTP1, NTP2 muscovy duck lines through 3 generatens.

- Commercial muscovy duck crossbred NTP12 and 2 pure muscovy duck NTP1, NTP2 lines were raised commercially.

2.1.2. Location

Thuy Phuong Poultry Research Center, Thuy Phuong, Bac Tu Liem District, Hanoi.

2.1.3. Period

From 2019 to 2022

2.2. CONTENT OF RESEARCH

2.2.1. Selection to create 2 NTP1 and NTP2 lines

- NTP1 male line with a large body weight and stable egg performance.

- NTP2 female with high egg performance and stable body weight.

2.2.2. Evaluation of meat production ability of commercial crossbred NTP12 muscovy duck

2.3. METHODS OF RESEARCH

2.3.1. Method for content 1: Selection to create 2 NTP1 and NTP2 lines

2.3.1.1. Line creation diagram

NTP1 muscovy duck was created from A male, B unisexual R71SL female, created parental AB, radical crossbred with A male to create 3/4 A, similarly C male, D female was used to create parental CD, radical crossbred with C male to create 3/4C as thematerial to create NTP2 male line.

2.3.1.2. Method to build a data collection system

Numbering individuals: Generaten using 1 digit (1,2,3,4), sex using 1 digit (1 is blank, 2 is female), muscovy duck using 4 digits (0001, 0002.....).

The form to record data for pedigree building and calculation includes: number of individuals, number of fathers, number of mothers, date of hatching, generaten, sex and traits.

Method of collecting individual data: The muscovy duck were numbered at 1 day of age and at the time of selection on gilts (number of individuals); joined into families in an individual cage system. Breed eggs were marked for hatching by individual mother, family and line, used the individual hatching tray system.

Traits for individual monitoring include: body weight at 8, 24 weeks of age, egg performance up to 38 weeks of age, egg weight at 37-38 weeks of age.

2.3.1.3. Selective method

* Selective method and number of muscovy ducks at different generations

+ Initial generation, 1st generation (selected by phenotypic value)

Weeks of age	Male line	Female line
01 day age	IG: 1,800 muscovies (900♂+900♀) GN1:1,550 muscovies (700♂+850♀) (Select individuals with fluffy feathers, bright eyes, shiny pink legs, pink bill, straw yellow feathers, with or without black spots on the head. with fluffy feathers, bright eyes, shiny pink legs, pink bill, straw yellow feathers, with or without black spots on the head).	IG:1,800 muscovies (900♂+900♀) GN1:1,600 muscovies (750♂+850♀) (Select individuals with fluffy feathers, bright eyes, shiny pink legs, pink bill, straw yellow feathers, with or without black spots on the head. with fluffy feathers, bright eyes, shiny pink legs, pink bill, straw yellow feathers, with or without black spots on the head).
	↓	↓
End of 8 weeks age	IG: selected 116♂+352♀ GN1: selected 122♂+359♀ for heifer (Free-feeding muscovy duck up to 8 weeks of age, weigh individuals of the whole herd, selected individuals	IG: selected 173♂+524♀ GN1: selected 172♂+526♀ for heifer. (First week of free feeding, from 2 weeks of age, quantitative feeding, at the end of 8 weeks of age, weighed

	with weight from high to low, male ≥ 3,150g, female ≥ 2,150g)	individuals for the whole herd, selectively stabilized, males were selected from 2,750 to 3,050g, females were selected from 1,650 to 2,000g)
	↓	↓
End of 24 weeks age	IG: selected 80♂+278♀ G1: selected 84♂+284♀ for reproduction (Weighed individuals of the whole herd, select individuals with body weight from 4,550 to 5,600g, females from 2,600 to 3,600g)	IG: selected 117♂+412♀ G1: selected 118♂+417♀ for reproduction (Weighed individuals of the whole herd, select individuals with body weight from 4,300 to 5,150g, females from 2,250 to 2900g)
38 weeks age	IG and GN1: selected 30♂+150♀ to replace herd for the next generation (Steady selection for egg performance, selected individuals with egg performance from 26 to 46 eggs)	IG and GN1: selected 30♂+150♀ to replace herd for the next generation (Oriented selection for egg performance, selected individuals with high to low egg performance ≥ 49 eggs)

+ 2nd generation, 3rd generation (selected by estimated breeding value)

Weeks of age	Male line	Female line
01 day age	GN2:1,450 muscovies (650♂+800♀) GN3: 900 muscovies (370♂+530♀)	GN2:1,500 muscovies (700♂+800♀) GN3:1,230 muscovies (480♂+750♀)
	↓	↓
End of 8 weeks age	GN2: selected 116♂ + 354♀ GN3: selected 74♂+252♀ for heifer (Free-feeding muscovy duck up to 8 weeks of age, weighing individuals for the whole herd, individuals were selected with breeding value traits of body weight at 8 weeks of age from high to low, breeding value of male ≥ 105.87, breeding value of female ≥ 21. 97)	GN2: selected 172♂+508♀ GN3:selected 141♂+502♀ for heifer. (First week of free feeding, from 2 weeks of age, quantitative feeding, at the end of 8 weeks of age, the whole herd was weighed, the selection was stable, for male, individuals were selected with a breeding value from -152.38 to 191.61; the female, individuals were selected from -208.07 to 184.03)

	↓	↓
End of 24 weeks age	GN2: selected 83♂+283♀ GN3: selected 55♂+211♀ for reproduction (Weighed individuals of the whole herd, select individuals with body weight from 4,550 to 5,600g, females from 2,600 to 3,600g)	GN2: selected 121♂+408♀ GN3: selected 104♂+419♀ for reproduction (Weighed individuals of the whole herd, select individuals with body weight from 4,300 to 5,150g, females from 2,250 to 2,900g)
38 weeks age	GN2 and GN3: selected 30♂+150♀ to replace herd for the next generation (Steady selection for egg performance, selected individuals with a breeding value of egg performance from -5.74 to 4.18)	GN2 and GN3: selected 30♂+150♀ to replace herd for the next generation (Oriented selection for on egg performance, selected individuals with high to low egg performance, selected individuals with breeding value ≥ -0.86)

2.3.2. Method for content 2: Evaluation of meat production ability of commercial crossbred NTP12 muscovy duck.

2.3.2.1. Diagram of creating commercial muscovy duck.

Parent ♂NTP1 x ♀NTP2

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Commercial muscovy duck NTP12

2.3.2.2. Experimental arrangement of commercial muscovy duck

- Used one factor random method to evaluate the meat production ability, heterosis of commercial muscovy duck.

- To evaluate the meat production ability, heterosis of commercial muscovy duck were arranged with 150 NTP12 and 150 NTP1 muscovy ducks; 150 NTP2 muscovy ducks raised under the same conditions, each plot was repeated 3 times, each time 50 muscovy ducks (25 males + 25 females).

2.4. DATA PROCESSING METHODS

Collected data were processed by statistical method using Excel 2010 and minitab 18, SAS 9.0 software. Used the REML (Restricted Maximum Likelihood) method to estimate genetic parameters run on VCE6 software. Used

BLUP method (Best Linear Unbiased Prediction), animal model (animal model) to estimate breeding value (BV running on PEST software.

CHAPTER 3. RESULTS AND DICUSSIONS

3.1. SELECTION TO CREATE 2 NTP1 and NTP2 LINES

3.1.1. Selection to create NTP1 male line muscovy duck

3.1.1.1. Effects of generation and sex on body weight of 8-week-age muscovy duck

To get a basis for selection a statistical analysis model, we have considered the influence of some fixed factors on selected traits. The analysis showed that the factors of generation and sex both having an effect on the 8 weeks age body weight trait with $p<0.001$

3.1.1.2. Composition of variance and heritability of 8 week age body weight selected trait and related traits

Table 3.1. Composition of variance and heritability of body weight, egg performance and egg weight traits

GN	Paramete	BW8	BW 24	EP38	EW38
GN1	σ^2_A	71,054.8	50,207.1	38.6	15.9
	σ^2_E	58,078.0	57,290.1	78.6	15.0
	σ^2_P	129,132.8	107,497.2	117.2	30.9
	h^2±SE	0.55±0,07	0.47±0.10	0.33±0.08	0.52±0.13
GN2	σ^2_A	62,709.5	64,812.3	31.4	13.1
	σ^2_E	62,443.0	65,824.5	77.5	15.5
	σ^2_P	125,152.5	130,636.8	108.9	28.6
	h^2±SE	0.50±0.06	0.50±0.08	0.29±0.12	0.46±0.11
GN3	σ^2_A	55,381.7	40,122.4	26.5	11.7
	σ^2_E	64,653.7	63,233.2	74.2	16.0
	σ^2_P	120,035.4	103,355.6	100.7	27.7
	h^2±SE	0.46±0.06	0.39±0.09	0.26±0.11	0.42±0.11

The genetic variance of body weight trait at 8 weeks of age over 3 generations was relatively high, specifically 71,054.8; 62,709.5; 55,381.7 accounts for 46.14-55.02% of the phenotypic variance; This shows that the heritability of this trait was relatively large in all 3 generations, so it would be favorable for the improvement of the trait through selection. In contrast, the genetic variance component of the egg performance trait in 3 generations had a

small value of 38.6; 31.4 and 26.5 account for 26.3-32.9% of the phenotypic variance, which shows that the heritability of this trait was low, so the genetic improvement depended on the phenotypic variance. on external factors. The heritability of the 8 weeks age body weight trait of the NTP1 male line was high (h^2=0.46), and the 38-week-age egg performance was moderate (h^2=0.26).

3.1.1.3. Covariance among traits

The genetic covariance of among BW8 – BW24; BW8 – EW 38; BW 24 – EW 38 was a positive and corresponding value of 43,830.4; 279.5 and 118.8; so genetic among these traits tend to vary in the same direction, phenotypic covariance was positive (69,748.6; 131.2 and 84,3) indicating phenotypically the pairs of traits This also varied in the same direction depending on the level.

The genetic covariance between BW8 - EP38; BW24 – EP38 was negative (-54.9 and -161.6), so genetic between these traits tends to vary in the opposite direction, phenotypic covariance was positive (204.2 and 135.1) show that phenotypically, these pairs of traits had the same variation depending on the degree.

The genetic covariance between the traits EP38 – BW38 was negative and a value of -9.5, the phenotypic covariance also had a negative value of -8.2. Thus, both genetically and phenotypically, these two traits tended to vary in opposite directions.

3.1.1.4. Genetic and phenotypic correlation between body weight and egg performance and egg weight

The correlation between BW 8 and BW 24 weeks of age was is a very strong positive (rG=0.93). Thus, in the procees of selecting the trait of BW 8 weeks age, the trait of BW at 24 weeks of age will be improved.

Table 3.3. Genetic correlation and phenotypic correlation among 3 generation traits

Paramatters	BW8	BW24	EP38	EW38
BW8		0.93±0.05	-0.05±0.17	0.35±0.13
BW24	0.63		-0.16±0.17	0.17±0.15
EP38	0.06	0.04		-0.54±0.17
EW38	0.07	0.05	-0.16	

Note: values above the diagonal were genetic correlations, below the diagonal were phenotypic correlations

The genetic correlation between body weight at 8 weeks of age and egg performance at 38 weeks of age was negative, with a very low value of -0.05. This shows that, genetically, the muscovy duck of the NTP1 male line with the genetic value of high body weight trait, the genetic value of egg performance trait was lower. However, this was a weak correlation, so the mutual influence of the two traits was insignificant. This was the basis for selection to increase body weight while maintaining stable egg performance of NTP1 male muscovy duck.

There was a positive correlation between body weight at 8 weeks of age and egg weight at 38 weeks of age (rG=0.35). Therefore, when selecting the trait for body weight at 8 weeks age, it would be improved the egg weight of 38 weeks age.

3.1.1.5. Breeding value and genetic progress of the body weight trait at 8 weeks age.

Table 3.4. Breeding value and genetic progress of the weight trait at 8 weeks age body

Generation	**n (muscovy duck)**	**Average breeding value**		
		Male	**Female**	**Mean**
Initial	1800	-108.52	-97.17	-102.85
GN1	1550	-10.62	1.68	-3.87
GN2	1450	72.02	66.56	69.01
GN3	900	171.40	152.41	160.22
Genetic progress (g)		92.24	81.36	86.21
P		0.001	0.003	0.002
Coefficient of determination (R^2)(%)		99.88	99.42	99.69

Breeding value of the trait of body weight at 8 weeks age was increased gradually over the generations, this trend was shown in both male and female muscovy duck, which was completely consistent with the rule of selection. In the process of selecting a trait that was selectively interested, the gene frequency of that trait tended to increase, but the breeding value was a measure of the ability to transmit genes from parents to offspring due to that through generations of selective breeding value if effective selection having increasing

was completely appropriate. Genetic progress of 8 weeks age male muscovy duck's body weight gain was increased by 92.24g/generation and male were 81.36g, average male and female was 86.21g/generation, thus the rate of genetic improvement in male muscovy duck was all higher than female over the generations, but the difference was not much The P value of the regression analysis of the breeding values of all traits was less than 0.01, showing high confidence in genetic progress. The coefficient of determination R^2 at a high level of 99.69% shows that the average breeding value over generations of the 8-week-age body weight trait was consistent with the linear regression line and it partly reflected the improvement genetic improvement of selected traits fairly evenly over generations, consistent with the herd size and selection pressure of the NTP1 male line.

3.1.1.6. Selection rate, selection differential and expected selection response of the 8-week-age body weight trait.

Body weight of NTP1 male line at 8 weeks age was increased gradually over each generation, male offspring was from 3,117.20g, female from 2,114.10g (initial generation) to 3,408.33g and 2,311.15g in generation 3. This difference was statistically significant with $p<0.001$. Selection differential for body weight of male muscovy duck at 8 weeks age was 201.67 - 487.80g, much higher than that of female muscovy duck with only 134.51 - 233.57g. This is explained because the breeding rate of male muscovy duck was much lower than that of female muscovy duck. In generations, the breeding rate for male muscovy duck was 3.44-8.33%, while the breeding rate for female muscovy duck was high from 17.12 to 28.90%.

The expected selection response for the 8-week-age body weight trait in male and female NTP1 muscovy duck tended to decrease over generations. Specifically in the 1st generation, this efficiency was 210.11g in the male and 96.63g in the female. By the 3rd generation, it was reduced to 92.77g in the male and 61.88g in the female. And the expected selection response of body weight trait in both studies showed that the selection response of males was higher than that of females, this is explained by the very strict selection rate of males was much lower than the female. From the results of genetic analysis and phenotypic results of selected traits, it can be seen that there was no difference between the expected selection response and the direct selection response.

(Calculated through regression of breed value) was lower than the expected selection response, which can be explained by the body weight trait at 8 weeks of age of the NTP1 male line with very high heteeosis, the selection differential was large, so the selection work was easy and the selection efficiency was as expected.

3.1.1.7. Genetic and phenotypic trends of body weight at 8 weeks of age

The results of the analysis of genetic trends and phenotype reflect that the phenotype and breeding value have the same general trend, both increased over generations. The direct selection effect (computed through regression of the seed value) compared with the expected selection effect was roughly equivalent. Because the 8-week-age weight trait of the male NTP1 muscovy duck had a high heritability and high heritability, it was very favorable for genetic improvement of this trait through selection. On the other hand, with proper raising conditions, the NTP1 male line can grow, develop and promote its full genetic potential through generations.

3.1.1.8. Survival rate, feed consumption of NTP1 male muscovy duck in growing and gilt stages through generations.

The survival rate in the growing stage was high, for male muscovy duck, the survival rate was increased from 96.89% in the initial generation to 97.30% in the 3rd generation, the female was increased from 97.33% to 98.11%. In the post-gift stage, the survival rate of male muscovy duck was increased from 98.28% in the initial generation to 98.65% in the 3rd generation, and the female was increased from 96.59% to 98.41%. Thus, selection through 4 generations of NTP1 male lines that had better adaptability and disease resistance in raising and climate conditions in Vietnam. Feed consumption in growing stage was 7.13-7.49kg, female was 5.91-6.07kg. In the period of 9-24 weeks of age, limited feeding, the amount of feed consumed for male muscovy duck was 24.0-24.53 kg, and for female muscovy duck was 14.65-14.68kg.

3.1.1.9. Body weight at 24 weeks of age of the NTP1 male line

At the end of 24 weeks of age, the body weight of male muscovy duck in initial generation was 4,963.16g. in the 3rd generation was 5,065.07g (increase of 2.05%), from 2,818.38g, increased to 2,862.10g (up by 1.55%). The selection

rate of male muscovy duck was 70.00-75.34% lower than that of females (80.68-85.08%).

3.1.1.10. Laying age, body weight of female, egg weight of NTP1 male line at laying and 38 weeks of age

The laying age of NTP1 male line was 202-205 days. The body weight of female at laying was tended to increase gradually over generations with 2,908.33-2,981.67g. The egg weight of NTP1male line at laying was 69.60-70.20g, by 38 weeks of age, it was 81.14-81.96g.

3.1.1.11. Laying rate, egg performance and feed consumption/10 eggs of NTP1 male muscovy duck in cycle 1 through 4 generations

Laying rate, egg performance/hen of NTP1 male line has increased gradually over the laying weeks, peaked at 7-8 weeks of laying, then gradually decreased in the next laying weeks and decreased sharply at 25-28 weeks of laying. because at that time, some swans appeared in the herd with molting and brooding, which reduced egg performance. Specifically, in 1-2 weeks of laying, egg performance of NTP1 male muscovy duck line was 3.30-3.67 eggs/hen, laying rate was 23.54-26.19%.

By 7-8 weeks of laying, the egg performance/hen has increased to 10.41-10.64 eggs/hen, the laying rate was 74.38-75.99%. At 23-24 weeks of laying, egg performance has decreased sharply to only 3.24-4.23 eggs/hen, the laying rate decreased to 23.16-30.24% and to 27-28 weeks of laying eggs/hen. and 1.57-2.16 eggs/hen, laying rate was only 11.21-15.45%. The egg performance /hen/cycle 1 of the NTP1 male line had tendity to decrease slightly over generations, which can be explained by the selection method and the purpose of creating high body weight male lines leading to high body weight. Laying rate and egg performance /hen/cycle 1 tended to decrease. However, still within the stable range of generation (range from 90.15 to 91,25 eggs.

3.1.1.12. Feed consumption/10 eggs of NTP1 male line muscovy duck through 4 generations

In the initial generation of the NTP1 male line, the lowest feed consumption of 10 eggs in cycle 1 was 4.91 kg. This indicator was increased

slightly and remained stable over selected generations. In the 3rd generation, the feed consumption per 10 eggs of NTP1 male line muscovy duck was 5.09 kg

3.1.1.13. Hatching results through 4 generations of NTP1 male line muscovy duck

Hatching results were collected during 27 laying weeks of cycle 1 showed that the embryo egg percentage of NTP1 male line through 4 generations was 92.79-92.93%. Hatching percentage/total hatching eggs was 79.96-80.57%. Hatching percentage/embryo egg percentage was 86.17-86.76%. The type 1 muscovy duck percentage/total alive hatched muscovy duck were 95.20-95.36%. So, these indicators were stable through generations.

3.1.2. Selection to create NTP2 female line

3.1.2.1. Effects of generation and sex on egg performance of 38-week-age muscovy duck

The analysis results showed that the generation factor mostly influenced to 38-week-age egg performance with $p<0.001$. The database of NTP2 females through 4 generations was quite large, the analysis results have shown that the influence of generation factors on the egg performance trait at 38 weeks age had a high confident level. Therefore, the selection of fixed influence factors to include in the genetic statistical model with the egg performance trait through generation was completely appropriate.

3.1.2.2. Composition of variance and heritability of egg performance selected trait at 38 week age and related traits.

The genetic variance of the egg performance trait at 38 weeks age had a small value and tends to decrease over generations from 46.3 in the 1st generation to 37.1 in the 3rd generation. The phenotip variance was increased through generations, from 78.3 in generation 1 to 85.6 in generation 3. The rate of the cumulative genetic variance to the phenotypic variance of this trait is only 37.16% in the generation. 1 and decreased to 30.24% in the 3rd generation, whereas the rate of the external variance to the phenotypic variance increased from 62.84 in the 1st generation to 69.76% in the 3rd generation, thus egg performance traits were greatly influenced by environmental conditions in addition to the influence of cumulative genetic composition.

Table 3.12. ***Composition of variance and heritability of performance selected at 38-week age egg trait and related traits through generations***

GN	Parameters	BW8	BW 24	EP38	EW38
GN1	σ^2_A	67,362.4	33,017.2	46.3	26.1
	σ^2_E	49,033.3	38,047.5	78.3	25.6
	σ^2_P	116,395.7	71,064.7	124.6	51.7
	h^2±SE	0.58±0.09	0.46±0.09	0.37±0.10	0.51±0.12
GN2	σ^2_A	49,774.4	28,691.4	42.0	19.6
	σ^2_E	52,825.7	38,130.4	83.0	23.1
	σ^2_P	102,600.1	66,821.8	125.0	42.7
	h^2±SE	0.49±0.09	0.43±0.07	0.34±0.09	0.46±0.10
GN3	σ^2_A	41,463.1	24,856.3	37.1	14.1
	σ^2_E	53,027.9	36,738.5	85.6	20.6
	σ^2_P	94,491.0	61,594.8	122.7	34.7
	h^2±SE	0.44±0.10	0.40±0.08	0.30±0.07	0.41±0.09

The change of variance components caused the heritability of the 38-week-age egg performance trait to change over specific generations from 0.37 in the 1st generation to 0.30 in the 3rd generation.

3.1.2.3. Covariance among egg performance at 38 weeks age selection and related traits

Genetic covariance, phenotypic covariance between the trait pair of body weight at 8- and 24-weeks age had positive values of 24,322.0 and 17,502.9, which indicated that either genetic or phenotypically two these traits all tended to change in the same direction.

For the body weight at eight-week-age and egg performance at 38-week-age, the genetic and phenotypic covariances were significantly negative, namely -820.9 and -421.5. These two traits tended to vary in both genetic and phenotypic terms.

The genetic covariance between body weight at 8- and 24-week age and egg weight at 38-week age was positive specifically 545.7; 346.3, phenotypic covariance was also positive 835.6 and 330.1. Thus, these two traits tended to vary in the same direction both in terms of genetics and phenotypes.

3.1.2.4. Genetic correlation coefficient and phenotypic correlation between 38-week-age egg performance selection trait and related traits

Table 3.14. Genetic correlation coefficient and phenotypic correlation among body weight, egg performance and egg weight

Parameters	BW 8	BW 24	EP 38	EW 38
BW 8		0.76±0.14	-0.66±0.24	0.71±0.11
BW 24	0.23		-0.33±0.23	0.58±0.16
EP 38	-0.12	-0.15		-0.34±0.20
EW 38	0.46	0.23	-0.32	

Note: values above the diagonal were genetic correlations, below the diagonal were phenotypic correlations

The genetic correlation between body weight at 8 weeks of age and egg performance at 38 weeks of age was negative at a tight level of -0.66. This shows that the genetic value of NTP2 females for body weight was hight, the genetic value for egg performance was low. In other words, selectively improving egg production will reduce body weight and vice versa. The degree of this genetic influence between these two traits was quite large, so when selected to improve egg production while maintaining body weight, it was necessary to select body weight at 8 weeks age on certain level. something to keep this trait stable or keep it low. The external correlation between these two traits was a weak positive correlation (0,19). In other words, in case of the external conditions changed, it can simultaneously influence to these two traits in the same direction. Because the environmental correlation was low, the phenotypic correlation depended on genetic correlation and was also negative but at a lower level (-0.12). Thus, on the NTP2 female line, phenotypically still shown high body weight individuals, the egg performance maybe low and vice versa. However, the negative phenotypic correlation was low, so there were still many individuals that show irregular phenotypic values that can have high body weight, still high egg performance and also many individuals, even though small, with high low egg performance.

3.1.2.5. Breeding value and genetic progress of the egg performance trait at 38 weeks age

Table 3.15. Estimated breed value of egg performance at at 38 weeks age.

Generation	IG	GN1	GN2	GN3
Number of individuals (muscovy duck)	1,800	1,600	1,500	1,230
Average breed value	-1.82	-1.33	-0.4	1.43
Genetic progress (egg)				1.068
P				0.038
Coefficient of determination (R^2) (%)				92.54

Breed value of egg performance performance at 38 weeks age tended to increase gradually over generations, from -1.82 in the initial generation to 1.43 in the 3rd generation, positive regression coefficient, genetic progress. conveying 1,068 eggs/generation, the coefficient of determination 92.54% with $p<0.05$, thus, the calculated data in generations had a high level of confidence.

3.1.2.6. Selection rate, selection differential and expected selection response of the 38-week-age egg performance trait.

The NTP2 male line was selected for egg performance, so at 38 weeks of age, the muscovy duck were selected more rigorously than the NTP1 male line. The selection rate at 38 weeks of age was 36.14-42.74%, the breeding rate was 17.16-20.35%. Through selective generations, egg performance at 38 weeks of age of NTP2 hens was 50.29 eggs, an increase of 4.08 eggs compared to the initial generation. The selective divergence of egg performance was gradually decreased over the generations with 10.54 eggs in the initial generation and 6.75 eggs in the 3rd generation. The selection differential initial of generation was relatively high (10.54 eggs) due to a high variational degree in egg performance (23.27%), the large difference between individuals selected to breed for offspring and the whole population. In the next generations, the selection differential tended to decrease gradually, which shownt that the muscovy duck herd became more and more uniform and stable in terms of performance after the selection process.

Selective response depended on many factors, including selective differential. From the results of genetic analysis and phenotypic results of the

egg performance selection trait at 38-week-age, it can be seen that the expected selection response and the direct selection response (calculated by regression breeding value) had a difference in the direction that the direct selection response (1,068 eggs) was lower than the expected selection response (2.07 eggs). This was completely appropriate and reasonable, because egg performance was a reproductive trait with low heritability, in addition to genetic influence, this trait was also ìnluence by environmental factors. so the actual selective response was not as expected.

3.1.2.7. Survival rate and feed consumption of NTP2 female line muscovy duck.

The survival rate of NTP2 muscovy duck line was high, at the end of growing stage, the survival rate of male muscovy duck was 96.86-97.89%, and the femle was 97.11-98.27%. In the gilt period, the survival rate of male muscovy duck was 96.53-97.87%, and female muscovy duck was 97.33-98.48%. Feed consumption/ muscovy duck/stage of NTP2 female line muscovy duck was low, at the end of 24 weeks age, male muscovy duck were 26.62-26.69kg, femele muscovy duck were 13.52-13.59kg.

3.1.2.8. Body weight at 8 and 24 weeks of age through 4 generations

Body weight at 8 weeks of age in NTP2 female muscovy duck line was stable through selective generations, males were 2,813.65-2,860.50g, females were 1,822.22-1,836.10g. Body weight at the end of 24 weeks of age corresponds to males were 4,705.80-4,738.32g, females were 2,520.43-2,583.04g.

3.1.2.9. Laying age, body weight of female, egg weight of NTP2 female line muscovy duck.

The laying age of NTP2 females was 190-192 days, the body weight at laying was 2,606.67-2,685.00g, at 38 weeks age, it ws 2,816.67-2,835.00g. Egg weight of NTP2 females when laying rate reached 5% was 68.38-68.64g, at 38 weeks age females 79.37-79.62g.

3.1.2.10. Laying rate, egg performance of NTP2 muscovy duck in cycle 1 through 4 generations

The laying age of NTP2 was increased gradually through laying weeks, peaked at 7-8 weeks of laying (80.12-84.08%), then decreased gradually through laying weeks and decreased to the lowest at 27-28th week of laying week.

(17.25-24.07%). The laying age /cycle 1 tended to increase gradually through generations, the lowest in the initial generation was 54.14% and the highest in the 3rd generation was 56.66% (increased by 2.52%).

The laying rate of NTP2 female muscovy duck through generations tended to be quite similar and followed the general rule of waterfowl. The laying rate of generation 3 was the highest in the laying weeks compared to the remaining generations.

The egg/hen/cycle performance of 3rd generation was the highest with 111.06 eggs. After 4 generations of selection, the egg performance of NTP2 female line increased by 4.95 eggs compared to the initial generation.

3.1.2.11. Feed consumption/10 eggs of NTP2 female line muscovy duck through 4 generations.

The average feed consumption/10 eggs of NTP2 female line muscovy duck through 4 selective generations was: 4.25; 4.15; 4.08 and 4.03kg. This result shows that selection for improving egg performance has reduced feed consumption/10 eggs. The higher the laying rate and egg performance, the lower the feed consumption/10 eggs and vice versa

3.1.2.12. NTP2 Hatching results through 4 generations of NTP2 female line muscovy duck

Each generation followed 27 incubations, the results showed that NTP2 female had the embryo rate of 94.52-94.84%, the hatching rate/total hatching rate was 81.23-81.52%, hatching rate/egg with embryos egg rate was 85.86-86.04%, the hatching rate of type 1/total number of alive hatched muscovy duck was 95.34-95.51%.

3.2. MEAT PRODUCING POTENTIAL OF COMMERCIAL NTP12 CROSSBRED

3.2.1. Conformation and size of some dimensions

*** Conformation**

At 1 day of age, the muscovy duck's feathers were lemon yellow, with or without black spots on the head, legs and pink bill. At 77 days of age, the muscovy duck's feathers were white, lustrous, with or without black spots on the head, legs and yellow skin, fast sharp eyes.

** Size of some dimensions*

The size of some basic measurements such as body length, bust, bust length, leg height and wing length of the commercial NTP12 crossbred muscovy duck were higher than that of the NTP2 and equivalent to the NTP1. The dimensions of muscovy duck were also higher than that of female, specifically on the muscovy duck, the body length was 29.58-31.83cm, the bust was 41.25-43.58cm, and the bust length was 18.42-19,75cm, these indicators were 25.67-27.75cm on females, respectively; 34.17-36.25cm; 15.58-16.67cm. The NTP12 crossbred muscovy duck had the body length, chest circumference, and breast length of the male muscovy duck with 31.42cm, 43.33cm and 19.33cm, respectively, 27.58; 36.0 and 16.67cm on females. At 11 weeks of age, the male muscovy duck had wing feathers of 18.08-18.67cm, and the hen's feather length was 20.42-20.75cm.

3.2.2. Survival rate through weeks of age

The NTP12 crossbred muscovy duck was created from NTP1 male muscovy duck and NTP2 female muscovy duck in the 3rd generation. Due to the high technical standards of reproductive muscovy duck, the survival rate in commercial crossbred muscovy duck was high. At the end of 11 weeks of age, commercial NTP12 crossbred muscovy duck had a survival rate of 97.33%, higher than that of purebred NTP1 muscovy duck (96.20%) and NTP2 (96.67%), but the difference was not significantly statistical significance ($p>0.05$).

3.2.3. Body weight by weeks of age

The weight of commercial crossbred muscovy duck, females and males were all increased gradually by the weeks of age and tended to be the same when analyzed the density of females and males, from 1 day of age to 2 weeks of age. There was no statistically significant difference, from 3 to 5 weeks of age, there was a statistical difference in the body weight of commercial crossbred muscovy duck among NTP12, NTP1 and NTP2 muscovy duck, which tended to be higher than that of. pure NTP2 muscovy duck (the difference was statistically significant) and asymptotically closed to that of the NTP1 muscovy duck (the difference was not statistically significant), from 6 to 11 weeks of age, the difference in body weight was very clear between NTP12 crossbred muscovy duck compared to NTP1 and NTP2 muscovy duck. This rule was the same both when analyzed the body weight of males, females and

the overall body weight of females and males.

Specifically, the NTP12 crossbred muscovy duck had an average body weight of 50.38g, higher than that of NTP2 and lower than that of NTP1 but not significantly. At 2 weeks age, the body weight of NTP12 crossbred muscovy duck was 390.81g, lower than NTP1 muscovy duck with 394.83g, higher than NTP2 muscovy duck with 375.27g. However, this difference was not statistically significant ($p>0.05$). At 3 weeks of age, this difference began to show more clearly between NTP12 crossbred muscovy duck, NTP1 and NTP2 muscovy duck, NTP12 crossbred muscovy duck with 720.74g equivalent to NTP1 muscovy duck was 731.15g, higher than NTP2 muscovy duck with $p<0.05$. Continuing to 5 weeks of age, NTP12 crossbred muscovy duck was 1,646.62g, equivalent to NTP1 muscovy duck with 1,679.05g, higher than NTP2 muscovy duck with only 1,473.99g. This difference in body weight was statistically significant between NTP12, NTP1 and NTP2 ($p<0.05$). By 7 weeks of age the difference in body weight was started to be more significant between crossbred and purebred in both male and female. At 7 weeks age the body weight of male, female, and female NTP12 crossbred muscovy duck was 3,078.77g, 2,244.52g, 2,661.64g, respectively, which were higher than the results achieved in NTP2 muscovy duck of 2,723.29g, 1,973.97g, respectively. 2,348.63g and lower than the results on NTP1 muscovy duck was 3,145.21g, 2,314.19g, 2,726.87g, this difference was statistically significant with $p<0.05$. This marked difference lasted up to 11 weeks of age. At the end of 11 weeks of age, NTP12 crossbred muscovy duck had a weight of 4,913.01g, 2,909.59g, and 3,911.30g, respectively, this result was higher than that of NTP2 muscovy duck with 4,319.86g, 2,556.25g, 3,444.14g, lower than that of NTP1 muscovy duck woth 5,001.39g, 2,982.64g and 3,992.01g, this difference was statistically significant with $p<0.05$. With the difference in body weight between commercial crossbred muscovy duck and pure gresse, the heterosis for crossbred muscovy duck achieved at 11 weeks of age was 5.20%.

3.2.4. Absolute and relative growth of commercial muscovy duck

The absolute growth rate of commercial NTP1, NTP2 and NTP12 muscovy duck was all increased gradually by weeks of age and peaked at week 6, then tended to decrease gradually over weeks of age. This was completely consistent with the law of growth, sexual development according to the stage of poultry.

Specifically, at 1 week age, the absolute growth of NTP1, NTP2 and NTP12 muscovy duck was only 13.52; 12.98; 13.30 g/ muscovy duck/day. From the 2nd week of age, the absolute growth rate in all 3 muscovy duck lines increased markedly, at the 4th week of age, it was 65.01; 54.19; 63.34g/ muscovy duck/day, respectively. And this rate continued to increase and peaked at week 6 was 75.78; 62.95; 73.08 g/ muscovy duck/day. By 11 weeks of age, the absolute growth rate decreased to only 28.67; 23.89; 27.79 g/muscovy duck/day. On average, for the whole period from 1 day age to 11 weeks age, absolute growth was 51.18; 44.08 and 50.14g. At all weeks of age, NTP12 crossbred muscovy duck had a high absolute growth rate, almost equivalent to NTP1 commercial muscovy duck and higher than that of NTP2 muscovy duck. This shows that the NTP12 crossbred muscovy duck has the same meat producing potential as the parent line. Relative growth tended to decrease gradually over the weeks of age and followed the general rule of relative growth of muscovy ducks with the form of a hypercarbon line. At 1 week of age, the relative growth of NTP1, NTP2 and NTP12 muscovy ducks was 96.26; 95.30 and 96.05%, respectively, then gradually decrease to 3 weeks of age reaching 59.74; 55.98; 59.36%, at 7 weeks age, it decreased quite deeply to 20.96; 20.36 and 20.89%. At the end of 11 weeks of age, this index decreased to a very low level of only 5.16; 4.98 and 5.10%. At all weeks of age, the growth rate of NTP12 crossbred muscovy duckswas equivalent to that of commercial NTP1 muscovy duck and higher than NTP2 muscovy duck

3.2.5. Feed consumption/kg body weight gain and heterosis

The efficiency of feed conversion of the experimental muscovy duck decreased gradually through the weeks of age or in other words, the feed consumption/kg body weight increased gradually by the weeks of age. Specifically, at 1 week of age, feed consumption/kg body weight gain of NTP1, NTP2 and NTP12 muscovy duck was 0.77, 0.81 and 0.79kg, respectively. By 7 weeks of age was 2.13; 2.38 and 2.19kg. And by 11 weeks of age was 2.67; 3.00 and 2.73kg.

At all weeks of age, NTP12 crossbred muscovy duck had higher feed consumption/kg body weight gain than pure NTP1 and lower than NTP2 muscovy duck. However, the difference between NTP12 and NTP1 crossbred muscovy duck was not as significant as that of NTP12 and NTP2. The hetteeosis

in terms of feed consumption/kg body weight gain of NTP12 crossbred muscovy duck was -3.69% compared to the average of the parents. Because the feed conversion efficiency of the NTP12 crossbred muscovy duck was also nearly equivalent to that of the NTP1 muscovy duck, the body weight of the NTP12 crossbred muscovy duck over weeks of age was also nearly equivalent to that of the NTP1 muscovy duck and significantly higher than that of the NTP2 muscovy duck.

3.2.6. Production index, economic index

The production index of muscovy duck lines tended to decrease gradually by the weeks of age and decreased sharply starting at 9 weeks of age. Specifically, the production index of NTP1, NTP2 and NTP12 muscovy duck up to 7 weeks age with 193.25; 143.40 and 182.43. At 9 weeks of age, it continued to decrease sharply to only 134.11; 122.70 and 147.31. And by 11 weeks of age, it decreased quite deeply to only 102.62; 75.85 and 97.47.

The economic index also decreased gradually by the weeks of age, by 11 weeks of age it decreased to only 3.44; 2.27 and 3.20. Therefore, in commercial muscovy duck raising, muscovy duck were usually sold at 10-11 weeks of age when production and economic index begin to decrease sharply to ensure high economic efficiency for farmers.

3.2.7. Some indexes of meat productivity survey

The NTP12 crossbred muscovy duck had a relatively high carcass rate of 75.66%, 1.08% lower than that of NTP1 and 3.31% higher than that of NTP2. The percentage of breast meat was 22.05%, 0.75% lower than that of NTP1 muscovy duck and 1.57% higher than that of NTP2 muscovy duck. The thigh meat percentage of crossbred muscovy duck was 18.24%, almost equivalent to NTP1 (18.62%), NTP2 muscovy duck was the lowest (16.67%).

3.2.8. Results of live meat production of a mother muscovy duck

To evaluate the efficiency of crossbreeding from parental herd to the final product that was commercial muscovy duck at 11 weeks of age. We arranged to raise a muscovy duck herd with NTP1 male population and NTP2 female population in the 3rd generation.

The result of live meat weight/mother muscovy duck/1 laying cycle of male muscovy duck NTP1 with NTP1 muscovy duck was 238.63kg; NTP2 male with NTP2 female was 259.57kg; NTP1 male with NTP2 female was

296.94kg. The comparison of live weight/1 female/1 laying cycle was 37.37-58.31 kg higher than that of both pure lines. The hetterosis achieved over the average parents was 19.20%.

3.2.9. Livestock efficiency

Commercial NTP12 muscovy duck had a high livestock efficiency of 4,482,662 VND for 150 muscovy duck, the average income/ muscovy duck was 29,884 VND.

In terms of breeding efficiency, raising NTP1 muscovy duck gived the highest efficiency and average income per head. However, if we consider the criterion of kg of live meat /1 hen /1 laying cycle, NTP12 crossbred muscovy duck raising brings the highest efficiency to farmers. This is the reason why breeding center often choose to raise male of male line and female of female line to achieve both parental muscovy duck raising efficiency and commercial muscovy duck raising compared to pure line breeding.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Selection to create 2 muscovy duck lines:

The selected body weight of NTP1 male line was increased from 9.32-9.34% compared to the initital generation, while the reproductive traits remained stable. The NTP1 male line had characteristics of uniform conformation, not dissociated over 4 generations. At 1 day of age, the muscovy duck 's feathers were lemon yellow, with or without black spots on the head, legs, and pink bill. Adult muscovy duck had pure white fur, with or without black spots on the head, yellow legs, pink bill. The body weight of male muscovy duck at 8 weeks age was 3,408.33g, female was 2,311.15g increased by 291g and 197g compared to the initial generation. The genetic progress of the male muscovy duck was 92.24 g/generation, the female muscovy duck was 81.36 g/generation, the common male and female muscovy duck was 86.21 g/generation. The heritability was high (h^2=0.46). The genetic correlation between body weight trait at 8 and 24 weeks age was very close at 0.93, mean that no need to select at 24 weeks of age. The body weight of muscovy duck at 24 weeks age was 5,065.07g, female muscovy duck was 2,862.10g. There was a moderate positive correlation between body weight at 8 and 38 weeks age (0.35). The egg weight at 38 weeks age was 81.96g. Egg performance/female/cycle 1 was 90.15 eggs,

feed consumption/10 eggs: 5.09kg, embryo rate was 92.93%, hatching rate/total hatching eggs was 80.35%, stable through generations.

The NTP2 female line was selected followng egg performance and increased 4.66 % compared to the initital generation, while the growing traits remained stable. Egg performance/male/cycle 1 was 111.06 eggs, 4.95 eggs higher than the initial generation. Genetic progress was 1,068 eggs/generation. Feed consumption/10 eggs was 4.03kg. The embryo percentage was 94.84%, the hatching rate/total eggs was 81.52%. The heritability of the 38-week-age egg performance trait was 0.3. Genetic correlation between egg performance at 38 weeks age- egg weigh at 8 weeks age was negative at a tight level (-0.66). between 38 weeks age- egg weigh at 24 weeks age was -0.33. Body weight of male muscovy duck at 8 weeks age was 2,813.65g, female muscovy duck was 1,826.73g; At 24 weeks age, the body weight of male muscovy duck was 4,705.80g, the body weight of female muscovy duck was 2,520.43g, stable over the generations.

2. The commercial NTP12 crossbreeding muscovy duck was the result of a crossing between the NTP1 male muscovy duck and the NTP2 female muscovy duck. By 11 weeks of age, the survival rate was 97.33%. Body weight of male muscovy duck was 4,913.01g, female muscovy duck was 2,909.59g; the average male and female was 3,911.30g with a heterosis for the body weight of 5.20%. Feed consumption/kg body weight gain was 2.73kg, heterosis was -3.69%. The carcasses percentage was 75.66%; The breast meat percentage was 22.05% and the thigh meat percentage was 18.24%.

Recommendations

Develop 2 commercial NTP1, NTP2 muscovy duck lines and crossbred NTP12 muscovy duck into production.