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Useful Repercussions on 10 and 12-Week Marketing Body Weights of Laying Ducks with Early Index Selection on Body Weights and Linear Measurements

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ABSTRACT

The ultimate breeding objective considered in this paper was to raise the profitability of laying duck producers by offering them a tool to increase body weight whenever accepting the expected consequences in terms of increase in weight of eggs and decrease in their number. This could be achieved by ameliorating the marketing body weight of surplus ducklings, normally used as a source of meat production, using information on their body weight and some body linear measurements recorded at early stages of life. Three selection indices were derived from data on 576 birds hatched and reared at the governmental, El-Serw Waterfowl Research Station, belonging to Animal Production Research Institute, located in Damietta, Egypt. These data represent records of 291 Domyati and 285 Khaki Campbell birds progeny of 40 sires and 160 dams. The traits considered as sources of information in the indices were body weight (BW), shank length (SL), keel length (KL) and breast girth (BG) recorded at 2, 4 and 8 weeks of age. In constructing the three indices (I_{w2}, I_{w4} and I_{w8} at weeks 2, 4 and 8, resp.) the aggregate genotype included body weights at 10 (BW_{w10}) and 12 (BW_{w12}) weeks of age. Phenotypic and genetic parameters were estimated from a multitrait-animal model where breed and sex effects were considered as fixed and the additive direct genetic effects as random. The results pinpointed that early selection hinged on I_{w4} (involving BW_{w4}, SL_{w4}, KL_{w4} and BG_{w4}) as juxtaposed to I_{w8} (including BW_{w8}, SL_{w8}, KL_{w8} and BG_{w8}) had comparable accuracy (0.47 vs. 0.49, resp.), expected gain in BW_{w10} (14.4 gm and vs. 14.7 gm, resp.) and expected gain in BW_{w12} (9.7 gm vs. 10.1 gm, resp.). Thereupon, I_{w4} would be the best possible index envisaging earliness, accuracy and efficiency.

Keywords: laying ducks, marketing body weight, selection index, early selection

INTRODUCTION

Ducks are known to have excellent adaptation to different environmental conditions (Yakubu *et. al*. 2015, Onbaşılar *et. al*., 2011) and can be reared on crop by-products and human food remnants (Rashid *et.al*., 1995). While Khaki Campbell (KC) and Domyati (DO) duck breeds have gained wide popularity at duck keepers (Banerjee, 2011) essentially for their higher egg production for incubation (Nys *et al*., 2011; Abd EL-Ghany, 2002), they are criticized for their relatively low marketing body weight as compared, at a constant age, to meat type breeds such as Muscovy and Pekin ducks (Batta, 2004). The issue becomes of more importance with surplus males and low egg producing females. Whereas among different selection methods, selection index is deemed the best (Anjana, and Goswami, 2012), early selection has the benefit of saving time and reduction of nutrition costs which represent 70% of the poultry project expenditure (Willems *et al*., 2013). Yet, information on genetic improvement of duck marketing body weight through index selection is scarce, especially when accepting the expected consequences in terms of increase in weight of eggs and decrease in their number.

The present work was carried out to construct three selection indices to improve marketing body weight, depending on body weight and three linear body measurements taken at 2, 4 and 8 weeks of age.

MATERIALS AND METHODS

1. Source of animals

A random sample of 291 Domyati (136 male and 135 female) and 285 Khaki Campbell (142 male and 143 female) ducks, progeny of 40 sires (20 for each breed) and 160 dams (80 for each breed) were used in the present study. Ducks were hatched and reared at the governmental El-Serw Waterfowl Research Station, belonging to Animal Production Research Institute, located in Damietta, Egypt.

2. Management and Feeding

Following their hatching, ducklings were wing-tagged and housed separately. Up to week 6, they were exposed to artificial light and fed *ad- libitum* on a commercial moisturized starter containing about 65% yellow corn and 35% soya bean meal with other supplements. The ration contained 19.2% crude protein and provided 2868 kcal/kg. From week 7 up to week 12, ducks were fed a commercial grower ration containing 15.2% crude protein and providing 2690 Kcal/kg.

3. Traits considered

At two weeks of age, body weight (BW, gm) and three linear body measurements, namely shank length (SL, cm), keel length (KL, cm) and breast girth (BG, cm), were taken at 4 and 8 weeks of age. Linear measurements were taken as previously described by Gouda *et al*. (2016). Body weights at week 10 (BWw10) and week 12 (BWw12) were recorded as marketing body weights.

4. Statistical analysis

Multitrait-animal model was used to analyse the considered traits using the VCE-6 software program package (Kovač *et al*., 2002) and the genetic and phenotypic parameters were estimated. The animal model in matrix notation was:

$$\mathbf{y = Xb + Za + e}$$

where:

y = the vector of observations traits;

b = the vector of fixed effects (breed and sex);

a = the vector of random additive genetic direct effects;

X and Z = known incidence matrices relating observations to the respective fixed and random effects with Z augmented with columns of zeros for animals without records and

e = the vector of random residual effects.

5. Definition of true breeding values

The breeding objective was to maximize the duck keeper's income through his selection for heavier marketing body weight at 10 or 12 weeks of age. The aggregate genotype (T) was defined as :

$$T = a_1\, gBW_{w10} + a_2\, gBW_{w12}$$

where :

gBW_{w10} = the additive genetic value for body weight at 10 weeks of age;

gBW_{w12} = the additive genetic value for body weight at 12 weeks of age;

a_1 and a_2 = the relative economic weights for BW_{w10} and BW_{w12} , respectively.

BW_{w10} and BW_{w12} were assumed to have the same economic weight in measuring the duck marketing body weight, and the relative economic weight of each trait was assigned to equal to one. The source of information (i.e. index traits) included BW, SL, KL and BG. Three selection indices were constructed (Cunningham *et al*., 1970) including all sources of information at 2, 4 and 8 weeks of age. The accuracy of selection and expected genetic gain in aggregate genotype traits were calculated.

RESULTS AND DISCUSSION

1. Means and heritabilities

Means and heritability estimates for body weight, shank length, keel length and breast girth at 2, 4 and 8 weeks of age and body weight at 10 and 12 weeks of age are presented in Table (1).

Table 1. Means ($\bar{x}$), coefficient of variation (CV%) and heritability and its standard error ($h^2 \pm$ SE) estimate for each considered trait

Trait	$\bar{x}$	CV%	h^2±SE
Body weight(gm) at:			
week 2 (BW_{w2})	290.4	21.56	0.20 ± 0.140
week 4 (BW_{w4})	526.9	12.72	0.32 ± 0.009
week 8(BW_{w8})	1286.8	6.82	0.46 ± 0.003
week 10 (BW_{w10})	1672.8	6.49	0.48 ± 0.005
week 12 (BW_{w12})	1882.4	10.83	0.47 ± 0.008
Shank length(cm)at:			
week 2 (SL_{w2})	3.1	5.12	0.21 ± 0.015
week 4 (SL_{w4})	5.6	4.50	0.46 ± 0.004
week 8 (SL_{w8})	6.8	2.35	0.44 ± 0.009
Keel length (cm) at:			
week 2 (KL_{w2})	2.4	5.70	0.36 ± 0.019
week 4 (KL_{w4})	4.6	4.57	0.46 ± 0.002
week 8 (KL_{w8})	9.1	1.87	0.37 ± 0.011
Breast girth (cm) at:			
week 2 (BG_{w2})	12.8	3.83	0.38 ± 0.015
week 4 (BG_{w4})	17.9	2.68	0.39 ± 0.019
week 8 (BG_{w8})	27.5	2.40	0.34 ± 0.033

The values for BW_{w10} and BW_{w12} were 1673 and 1882 gm, respectively. were lower than the value of 1974 gm obtained on Pekin ducks at 8 weeks old by Shahin and Saleh (1997) and higher than the value of 1490 gm recorded on Khaki Campbell breed at 10 weeks old by Yakubu *et al*. (2015). Difference of breeding and management between flocks would lead to difference in body weights at the same age for the same breed.

Body weight was more variable (6.49% to 21.56%) than body linear measurements (1.87% to 5.12%). Alike results have been reported in previous studies on breeds of ducks (Gouda *et al*., 2016; Ogah and Kabir, 2013).

The heritability estimates for all traits are shown to be low to moderate (0.20 to 0.48). The moderate heritability estimates for body weight at marketing (0.48, Table 1; 0.35, El-Sayiad *et al*., 1988; 0.37, Kosba *et al*., 1981; 0.53, Xu *et al*., 2011) indicate the possibility of improving this trait through direct selection. Yet, if the breeder ought to delay his culling decision until 10 weeks of age, then he should expect to face economic outlay such as more rearing costs and higher mortality rates.

2. Genetic and phenotypic correlations

Table (2) displays the genetic and phenotypic correlations between the traits considered in the present study.

Strong positive genetic correlation (0.88) between BW_{w10} and BW_{w12} was witnessed, indicating that culling at week 12 could be done successfully two weeks earlier.

Even if Shahin and Salah (1997) recorded high genetic correlation of 0.63 between 2-week body weight and 8-week marketing body weight on Pekin ducks, the present study on laying ducks estimated genetic correlations of only 0.27 and 0.13 between week 2 body weight and week 10 and week 12 body weights, respectively. However, week 4 body weight (BW_{w4}) and conformation (BG_{w4}) had instigating genetic correlations with marketing body at week 10 (0.23 and 0.53, resp.) and week 12 (0.30 and 0.35, resp.). This reveals the possibility of improving body weight at marketing, hinging on early selection at week 4.

3. Selection indices

Table (3) shows for each selection index: weighing factors, standard deviations, absolute and relative accuracy of selection and expected genetic gain.

Maximum accuracy (R^2 = 0.49) was recorded for I_{w8} including the information recorded at 8 weeks of age. Selection based on this index is expected to produce ducks that have 14.7 gm and 10.1gm rise in body weight at marketing at weeks 10 and 12, respectively. Comparable accuracy (R^2 = 0.47) and genetic improvement in BW_{w10} (14.4+ gm) and BW_{w12} (9.7+ gm) were recorded for I_{w4}. These results embolden taking the decision of selection on week 4 instead of week 8 with only 2% reduction in accuracy of selection. On the other hand, selection based on I_{w2} appeared to have no justifiable grounds as having a slim relative accuracy and trivial expected genetic gains.

CONCLUSION

Whenever accepting the expected consequences in terms of increase in weight of eggs and decrease in their number, it is conceivable to improve marketing body weight at 10 or 12 weeks of age of laying ducks with selection at week 4 using information on body weight (BW_{w4}), shank length (SL_{w4}), keel length (KL_{w4}) and breast birth (BG_{w4}), as follows:

$$I_{w4} = 0.18BW_{w4} - 84.37\ Sl_{w4} + 2.08\ KL_{w4} + 256.67\ BG_{w4}\ (R^2 = 0.47)$$

where expected genetic improvement in BW_{w10} and BW_{w12} were 14.4 and 9.7 gm, respectively with appended at least six week long rescuing avoidable nutrition costs and disbursements in terms of morbidities and mortalities. These useful repercussions would be more for-sighted with large flocks.

Table 2. Genetic and phenotypic correlations with marketing body weight at weeks 10 and 12

	Correlation estimates with:			
	BW_{w10}		BW_{w12}	
Traits	**genetic**	**phenotypic**	**genetic**	**phenotypic**
i. In aggregate genotype†				
BW_{w10}	-	-	0.88	0.69
BW_{w12}	0.88	0.69	-	-
ii. In selection index				
Body weight (gm) at:				
week 2 (BW_{w2})	0.27	0.24	0.13	0.25
week 4 (BW_{w4})	0.23	0.30	0.30	0.45
week 8(BW_{w8})	0.47	0.49	0.10	0.05
Shank length (cm) at:				
week 2 (SL_{w2})	0.20	0.21	0.14	0.17
week 4 (SL_{w4})	0.21	0.28	0.15	0.20
week 8 (SL_{w8})	0.51	0.51	0.38	0.41
Keel length (cm) at:				
week 2 (KL_{w2})	0.28	0.22	0.19	0.19
week 4 (KL_{w4})	0.08	0.10	0.04	0.05
week 8 (KL_{w8})	0.55	0.51	0.33	0.34
Breast girth (cm) at:				
week 2 (BG_{w2})	0.44	0.44	0.10	0.07
week 4 (BG_{w4})	0.53	0.53	0.35	0.42
week 8 (BG_{w8})	0.07	0.08	-0.14	-0.18

†: BW_{w10}: body weight at week 10, BW_{w12}: body weight at week 12

Table 3. Weighing factor for each selection trait, index standard deviation, absolute and relative accuracy of selection, and expected genetic gain in BW_{w10} and BW_{w12}

Selection		**Weighing factors (b-value) for† :**				**Index standard deviation**	**Accuracy of selection**		**Expected genetic gain (gm) in:**	
Age	Index	BW	SL	KL	BG	(σ_I)	absolute (r_{TI})	relative (%)$^{\phi}$	BW_{w10}	BW_{w12}
week 2	I_{w2}	0.207	19.02	193.25	-98.38	10.16	0.20	41	4.8	5.4
week 4	I_{w4}	0.18	-84.37	2.08	1256.67	24.06	0.47	96	14.4	9.7
week 8	I_{w8}	0.35	674.89	233.01	-69.46	24.91	0.49	100	14.7	10.1

†: BW= body weight, SL= shank length, KL= keel length, BG = breast girth; ϕ = relative to I_8.

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فوائد من جراء الانتخاب المبكر بالأدلة الانتخابية المتضمنة وزن الجسم وقياساته الخطيةعلى الوزن التسويقي للبط البياض عند عمري ١٠ ، ١٢ أسبوع

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استهدف هذا البحث رفع ربحية منتجي البط البياض في حالة القبول بالآثار المتوقعة من حيث زيادة في وزن البيض وانخفاض في عدده من خلال تحسين الوزن التسويقي للصغار الزائدة عن الحاجة، التي تستخدم عادة كمصدر لإنتاج اللحم، وذلك اعتماداً على أوزانها وبعض مقاييسها الخطية في أعمارها المبكرة. فقد صممت ثلاثة أدلة انتخابية تقوم على بيانات ٥٧٦ طائراً من إنتاج وتربية محطة السرو للطيور المائية، التابعة لمعهد بحوث الإنتاج الحيواني، والواقعة في محافظة دمياط بمصر. ولقد تناولت البيانات سجلات ٢٩١ طائراُ من البط الدمياطي ، و ٢٨٥ من البط الكاكي كامبل تمثل في مجموعها نسل ٤٠ أباُ و ١٦٠ أم. ولقد أخذ في الاعتبار عند بناء الأدلة أن مصادر المعلومات هي: وزن الجسم ، طول الساق ، طول العارضة ، ومحيط الصدر والمسجلة عند عمر ٢ ، ٤ ، ٨ أسبوع ، وأن صفات الوراثة الكلية للطائر هي وزنا الجسم عند العمرين ١٠ ، ١٢ أسبوع. قدرت المعالم الوراثية والمظهرية من خلال ما يعرف بالنموذج الإحصائي الحيواني متعدد الصفات الذى أتخذ السلالة والجنس كتأثيرات ثابتة ، والتأثيرات الوراثية التجمعية المباشرة كتأثيرات عشوائية. ولقد أوضحت النتائج أن الانتخاب المبكر المعتمد على الدليل الانتخابي عند عمر ٤ أسابيع مقارنة بذلك عند عمر ٨ أسابيع يحقق نتائجاً متقاربة في الدقة (٠.٤٧ مقارناُ بـ ٠.٤٩ على التوالي) وفي الزيادة المتوقعة في الوزن عند ١٠ أسابيع (١٤.٤ جم مقارناً بـ ١٤.٧ جم على التوالي) وفي الزيادة المتوقعة في الوزن عند ١٢ أسبوع (٩.٧ جم مقارناً بـ ١٠.١ جم على التوالي). وهو ما يحمل على الحكم بأن الدليل الانتخابي المُصَمَم عند عمر ٤ أسابيع هو الأفضل أخذاً في الاعتبار جوانب التبكير والدقة والكفاءة.