GENETIC PARAMETERS FOR SLAUGHTER AND MEAT TRAITS IN OSTRICHES

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SUMMARY

Genetic parameters for ostrich slaughter and meat traits were estimated to determine whether the improvement of slaughter yield through genetic selection will be possible. Live weight before slaughter, *post mortem* weight, carcass weight, pelvic limb weight, muscle weights and fat depot weights were recorded. Abdominal and subcutaneous fat weights were highly variable, while coefficients of variation in the other traits ranged between 16 and 29%. All traits showed significant genetic variation, with estimates of heritability ranging from 0.21 to 0.34 for weight and carcass traits. Heritability estimates for individual muscle weights ranged from 0.14 to 0.43, while the genetic correlations among the individual muscle weights and with pre-slaughter live weight were all positive. The substantial variation, high and favourable genetic correlations between traits, and moderate to high heritability estimates indicate that genetic improvement in ostrich carcass traits is achievable.

INTRODUCTION

Genetic improvement of carcass traits in farmed livestock species has become an important tool at the disposal of producers specialising in meat production. Improving the yield of ostrich carcass components of economic importance also needs to be investigated in light of the importance of meat production for the ostrich industry. To establish a breeding program to improve carcass composition and yield in ostriches, it is essential to gain knowledge of genetic parameters involving carcass traits. Since this is currently lacking, this study aimed to estimate genetic parameters for quantitative ostrich slaughter, carcass and meat traits. The relationships of these traits with body weight were also investigated.

MATERIALS AND METHODS

Slaughter data were collected from the progeny of the commercial ostrich breeding flock maintained at the Oudtshoorn Research Farm, South Africa, slaughtered from 1997 to 2011. Only data from South African Black ostriches, slaughtered between 210 and 540 days of age, were used. Contemporary groups for on-farm weight were defined as year by season to represent chicks that were reared in the same environment and management regime. Weight data from contemporaries not slaughtered, some of which later on became parents, could therefore also be included in the analysis. Slaughter date was used to derive contemporary groups (slaughter groups) for slaughter traits, thereby representing ostriches slaughtered under the same slaughter conditions. Slaughter groups were large similarly aged birds that were reared together for the months immediately preceding slaughter. The final dataset analysed represented the progeny of 305 sires and 298 dams, pair-mated to each other in 382 unique combinations. Ostriches were weighed on-farm, before being transported for slaughter and dressing at a local abattoir. The ostriches were fasted for 24 h, electrically stunned, hoisted by the legs and bled before the feathers, skins, internal organs and abdominal fat were removed. Slaughter data routinely recorded at the abattoir included *post mortem* weight (after bleed out) and warm carcass weight. The weights of the subcutaneous

fat and abdominal fat depots were also determined for some of the slaughter groups. A number of right pelvic limbs from various slaughter groups were also removed from the abattoir for further dissection and investigation. The weights of the pelvic limbs (leg and thigh) were determined after being chilled at 0°C for 24 h. Ten of the major muscles that are sold as commercial cuts were also dissected and weighed (Table 1).

Statistical analysis. Age was fitted as a linear covariate for all traits. Fixed effects fitted for all traits initially included contemporary group for live weight, slaughter group for slaughter traits and gender (male or female). Two-way interactions between these effects were also included in the initial models. Effects found to be significant were fitted in the final models for each trait.

Variance components were estimated by REML procedures fitting an animal model (Gilmour *et al*. 2009). Two random models were fitted. Model 1 only included the direct genetic effects, while maternal permanent environmental effects were added in Model 2. Live weight was analyzed in multi-trait analyses with carcass traits and groups of muscle weight traits, respectively. The three lower leg muscles (*Muscularis gastrocnemius pars interna, M. fibularis longus* and *M. gastrocnemius pars externa*) were analysed together, as was the four post-acetabular muscles (*M. iliofemoralis, M. flexor cruris lateralis, M. iliofibularis* and *M. iliotibialis lateralis*). The rest of the muscles (*M. femorotibialis medius, M. iliofemoralis externus* and *M. iliotibialis cranialis*), which could not be conclusively grouped according to location, was analysed together. All analyses included the full pedigree file, consisting of 6 541 individuals, the progeny of 378 sires and 376 dams, mated to each other in 541 unique combinations. Individuals hatched from generation one through seven were included.

RESULTS AND DISCUSSION

The average slaughter age was 373 ± 76 days. Abdominal and subcutaneous fat weights were highly variable as reflected by high coefficients of variation of >50%, while coefficients of variation in the other traits ranged between 16 and 29% (Table 1).

Table 1 Means (± s.d.), coefficients of variation (CV) and ranges for ostrich slaughter traits

Trait	N	Mean (± s.d.)	CV (%)	Range
Slaughter traits:				
Live weight (kg)	1 897	90.3 ± 19.3	21	42 – 146
Post mortem weight (kg)	1 052	84.2 ± 13.1	16	43.5 - 134.7
Carcass traits:				
Carcass weight (kg)	1 268	41.8 ± 7.3	17	20.1 - 62.7
Pelvic limb weight (kg)	976	14.8 ± 3.0	20	6.5 - 23.4
Abdominal fat weight (kg)	424	3.708 ± 2.035	55	0.238 - 10.220
Subcutaneous fat weight (kg)	737	2.687 ± 1.593	59	0.293 - 10.166
Muscle traits:				
M. gastrocnemius pars interna (kg)	738	0.793 ± 0.191	24	0.284 - 1.446
M. fibularis longus (kg)	738	0.263 ± 0.067	25	0.102 - 0.487
M. gastrocnemius pars externa (kg)	738	0.527 ± 0.150	28	0.192 - 1.157
M. iliotibialis lateralis (kg)	740	0.988 ± 0.230	23	0.268 - 1.560
M. iliofibularis (kg)	871	1.394 ± 0.339	24	0.368 - 2.400
M. iliofemoralis (kg)	775	0.357 ± 0.102	29	0.105 - 0.637
M. flexor cruris lateralis (kg)	740	0.285 ± 0.083	29	0.103 - 0.531
M. iliotibialis cranialis (kg)	739	0.445 ± 0.109	24	0.171 - 0.852
M. iliofemoralis externus (kg)	740	0.168 ± 0.039	23	0.077 - 0.289
M. femorotibialis medius (kg)	739	0.659 ± 0.136	21	0.312 - 1.171

N: number of records; s.d.: standard deviation; CV: coefficient of variation

Most carcass and meat traits were dependent on age (with the exception of *post mortem* weight and *Muscularis iliofemoralis* weight), with yield generally increasing with an increased slaughter age. Gender seemed to influence fat weights, with males having less fat, both in the abdominal and subcutaneous depots. Broiler males were also shown to be leaner than females (Zerehdaran *et al*. 2004). Nonetheless, ostrich females produced the same pelvic limb weight as males, as reported by Hoffman *et al*. (2009). It seems, however, that the contribution of different muscles to the thigh and leg may vary between males and females. Some muscles (*M. iliofibularis* and *M. femorotibialis medius*) were heavier in females, while some were heavier in males (*M. iliofemoralis externus*). Carcass composition thus seemed to differ slightly between males and females. This would be consistent with studies on chickens, which showed that female chickens had a higher breast yield, but lower thigh and drumstick yields than males (Baeza *et al*. 2010).

(Co)variance components, ratios and correlations. The inclusion of the direct genetic component as a random effect in the operational model resulted in an improved log-likelihood for all traits, with the exception of abdominal fat weight. The additional inclusion of the maternal permanent environmental effect in the operational model resulted in an improved log-likelihood for live weight, pelvic limb weight, subcutaneous fat weight and some of the muscle weights.

The direct genetic component was thus fitted as default for all traits, resulting in heritability estimates (h^2) of 0.22 ± 0.05 for live weight, 0.44 ± 0.08 for *post mortem* weight, 0.29 ± 0.06 for carcass weight, 0.18 ± 0.09 for pelvic limb weight, 0.09 ± 0.09 for abdominal fat weight and 0.16 ± 0.12 for subcutaneous fat weight in single-trait analyses. Significant heritability estimates were also obtained for most of the muscle weights. Maternal permanent environmental variance ratios (pe^2) accounted for between 5% (live weight) and 16% (*M. gastrocnemius pars interna* weight) of the phenotypic variation for the respective traits. However, the maternal permanent environmental effect for all traits became insignificant in multi-trait analysis and was thus not included in the final analysis involving any combination of traits. Results from a five-trait model including live weight and various carcass traits are given in Table 2.

Table 2 (Co)variance components and ratios (± s.e.), along with residual and phenotypic variances and correlations between ostrich live weight and carcass traits from multi-trait analyses

Trait	Live weight	Carcass weight	Pelvic limb weight	Abdominal fat weight	Subcutaneous fat weight
Additive genetic correlations (h^2 in bold)					
Live weight	**0.34 ± 0.06**	0.94 ± 0.03	0.90 ± 0.04	0.56 ± 0.16	0.92 ± 0.07
Carcass weight		**0.27 ± 0.06**	0.99 ± 0.01	0.47 ± 0.18	0.73 ± 0.12
Pelvic limb weight			**0.32 ± 0.06**	0.41 ± 0.19	0.67 ± 0.13
Abdominal fat weight				**0.22 ± 0.08**	0.63 ± 0.18
Subcutaneous fat weight					**0.21 ± 0.06**
Residual correlations (σ^2_e in bold)					
Live weight	**81**	0.71 ± 0.02	0.75 ± 0.02	0.62 ± 0.05	0.52 ± 0.04
Carcass weight		**21.6**	0.93 ± 0.01	0.62 ± 0.05	0.38 ± 0.05
Pelvic limb weight			**2.68**	0.54 ± 0.06	0.34 ± 0.05
Abdominal fat weight				**1.5**	0.48 ± 0.05
Subcutaneous fat weight					**1.3**
Phenotypic correlations (σ^2_p in bold)					
Live weight	**123**	0.78 ± 0.01	0.80 ± 0.01	0.60 ± 0.03	0.62 ± 0.02
Carcass weight		**29.7**	0.94 ± 0.00	0.58 ± 0.03	0.46 ± 0.03
Pelvic limb weight			**3.9**	0.50 ± 0.03	0.42 ± 0.03
Abdominal fat weight				**1.9**	0.63 ± 0.03
Subcutaneous fat weight					**1.7**

All heritability estimates were moderate. Genetic correlations were very high between live weight and carcass weight, as well as between live weight and pelvic limb weight. Carcass weight and pelvic limb weight were also highly correlated, the derived genetic correlation not differing from unity. A high genetic correlation was also found between live weight and subcutaneous fat weight, while the correlation between live weight and abdominal fat weight was lower. The residual and phenotypic correlations between the various weight traits (live weight, carcass weight and pelvic limb weight) and abdominal fat were mostly higher than those with subcutaneous fat weight though. The genetic correlation between abdominal fat weight and subcutaneous fat weight amounted to 0.63, with the 95% confidence interval for the correlation (0.27 - 0.99) just excluding unity. Residual and phenotypic correlations were comparable to genetic correlations in sign, but in some cases somewhat smaller or larger in absolute magnitude.

Moderate to high heritability estimates were found in multi-trait analyses for most of the individual muscle weights, with a range from 0.14 to 0.43. The genetic correlations among these individual muscle weights and pre-slaughter live weight were all positive and ranged from 0.59 to 0.82. Accordingly, genetic correlations among the weights of the respective muscles were also positive and ranged from between 0.45 and 0.99.

All traits therefore showed significant genetic variation in multi-trait analyses, while no significant maternal permanent environmental effect was evident for ostrich carcass and meat traits in these analyses. The estimates from multi-trait analyses were generally slightly higher compared to single-trait estimates. Heritability estimates were comparable to estimates for other species. Lotfi *et al.* (2011), for instance, reported heritability estimates of 0.59 for carcass weight and 0.28 for abdominal fat weight of Japanese quail.

Pre-slaughter live weight was highly correlated with carcass weight and pelvic limb weight. Unfortunately the genetic correlation between live weight and subcutaneous fat was also very high; indicating that selection for increased live weight and slaughter yield will increase the subcutaneous fat weight as well. If this fat can be exploited as a valuable oil, as is done in other ratite species (Sales 2007; Bennett *et al.* 2008), this could be beneficial though. The possible uses of ostrich fat should therefore be investigated further.

CONCLUSIONS

The derived heritability estimates indicate that genetic improvement in ostrich carcass traits is achievable. The estimated genetic relationships are mostly favourable, with a few exceptions, namely those involving fat depots. However, even though ostrich fat is currently treated as a waste product, the possibility for exploiting the fat as valuable oil needs further attention.

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