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Is genetic selection for skin nodule traits of ostriches feasible?

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Abstract

Preliminary genetic parameters for nodule traits of ostrich skins were estimated to examine whether genetic improvement of skin quality is feasible. Average nodule size and density per dm² were determined on five localities on each of 439 ostrich skins. An animal model with random animal and skin permanent environmental effects was fitted for the traits considered. Fixed effects were locality on skin, age, year of hatch and gender. Locality significantly influenced nodule size and nodule density. Nodule size increased with an increase in slaughter age, while nodule density decreased. Estimates for heritability were low at 0.10 for both traits, but still differed significantly from zero. The genetic correlation between nodule density and average nodule size was very high at –0.72. The skin permanent environmental correlation was –0.33, the environmental correlation –0.17 and the phenotypic correlation was –0.28. More research into genetic variation within localities and correlations with other easily measurable traits is indicated for genetic improvement of ostrich leather quality.

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Introduction

The feather follicles or nodules on ostrich skins make it unique and nodule size and shape are consequently important for leather quality. Whereas ostrich skins were previously graded solely according to skin damage and size, tanneries have recently added nodule size as a factor that determines grading, and therefore the value of the skin. This measure was adopted to control the increasing supply of skins with unacceptably small nodules, which resulted from the trend to slaughter ostriches earlier than the traditional 14 months of age, to minimize costs and risk (Meyer, 2003). The average nodule size gradually decreased, presumably due to the negative relationship of nodule size with slaughter age (Cloete *et al*., 2004).

Currently no genetic and environmental parameters are available for qualitative skin traits such as nodule size (Cloete *et al*., 2002). Due to this lack of scientific information a preliminary study was done where nodule size and density were measured to obtain objective values for estimation of genetic and environmental parameters to investigate the possibility of genetic improvement of ostrich skin traits.

Material and Methods

Approximately 500 crust skins, collected from ostriches slaughtered between 1997 and 2001 at ages of 4 to 16 months, were used. The ostriches were raised in the commercial flock maintained at the Klein Karoo Agricultural Development Centre. The origin, husbandry and management of the flock are well documented in the literature (Bunter & Graser, 2000). Pedigree records were available for 439 of these ostriches, which were subsequently used to estimate genetic and environmental parameters for two skin traits. For this purpose, average nodule size and density for each skin were determined at five localities of 1 dm^2 each, as described by Cloete *et al*. (2004). The localities were situated on the neck, mid-crown area, upper leg, lower flank and in the middle of the rear back area (butt – see Cloete *et al*., 2004 for details). The data were linked with pedigree records and genetic and environmental parameters were estimated with REML procedures, using ASREML (Gilmour *et al*., 1999). Trait means with corresponding standard errors were derived from models fitting age as a fixed effect. Age trend lines were also derived from models involving smoothing cubic splines (Verbyla *et al*., 1999). A spline consisting of a fixed linear component as well as random deviations from linearity conforming to a smooth trend was fitted to the data (Gilmour *et al*., 1999). Random deviations from linearity not conforming to a smooth trend was also fitted initially, but were insignificant and consequently dropped from the operational model. Other fixed effects included locality on the skin, year of hatch and gender. Log likelihood tests were conducted to identify the most suitable random effects model for each trait. Based on these results, a model containing random animal effects and skin permanent environmental effects (c^2) were fitted, at first in univariate analyses, and subsequently in a two-trait analysis to determine correlations between traits.

Results and Discussion

Nodule density showed more variation than nodule size, with an almost seven-fold difference between the lowest and highest number of nodules per dm^2 (Table 1). Both nodule density and nodule size varied significantly according to the location on the skin (Table 2), as reported previously (Cloete *et al*., 2004).

Table 1 Descriptive statistics for nodule density and average nodule size

Trait	Number of observations	Mean ± s.d.	Coefficient of Variation (%)	Range
Nodule density (number/dm^2)	2193	47.3 ± 15.8	33.4	17 – 114
Nodule diameter (mm)	2193	3.61 ± 0.55	15.2	2.17 – 5.41

Table 2 Means (± s.e.) depicting the effects of location on the nodule size and density on ostrich skins

Trait	Location on skin				
	Neck	Mid crown	Upper leg	Lower flank	Butt
Nodule density	51.8 ± 1.0^c	55.4 ± 1.0^d	25.6 ± 1.0^a	35.4 ± 1.0^b	55.6 ± 1.0^d
Nodule size (mm)	3.28 ± 0.03^a	3.27 ± 0.03^a	3.77 ± 0.03^b	3.95 ± 0.03^c	3.98 ± 0.03^c

^{a,b,c,d} - Means in the same row with different superscripts differ significantly ($P < 0.05$)

Skins from males have a slightly higher ($P < 0.05$) average nodule size than those of females (3.68 ± 0.03 *vs*. 3.62 ± 0.03 mm respectively), but nodule density was unaffected by gender ($P > 0.05$). The effect of hatching year was significant for both traits. Since year effects are transient and dependent on numerous climatic, environmental and husbandry factors, these effects are neither presented, nor discussed in detail.

Nodule size increased as slaughter age increased, while nodule density decreased as slaughter age increased (Figure 1). The trend for nodule density was more erratic than the upward trend for nodule size. At present, size is the only nodule trait of economic importance. It could, thus, be argued that ostriches should be slaughtered older to obtain leather of acceptable quality. Unfortunately, skin damage tends to increase with age (Meyer *et al*., 2002), thereby possibly nullifying the possible benefit gained in nodule size.

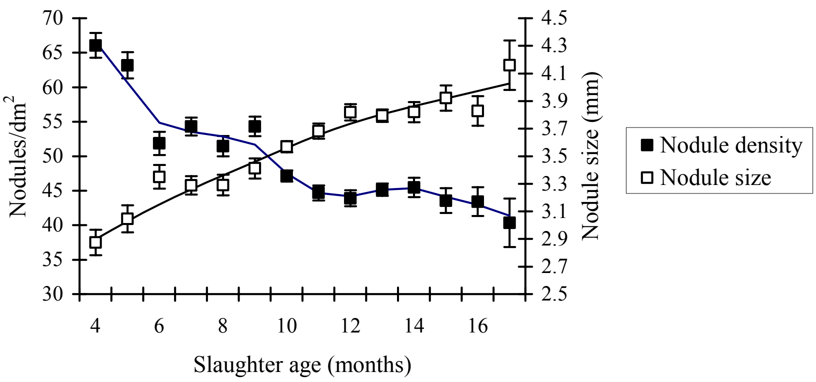

Figure 1 Number of nodules per dm^2 and average nodule size depicted against slaughter age. Vertical lines about means denote standard errors

Heritability estimates of both nodule density and nodule size was low at 0.10 for both traits, but still reached significance with a level of at least double the corresponding standard error (Table 3). It could thus be argued that there is some genetic variation to be exploited, but that a viable procedure to achieve this needs to be established. In general, the derived heritability estimates were lower than those previously reported for quantitative slaughter traits (Meyer *et al*., 2002). Skin c^2 was larger in magnitude, but of limited value in this particular instance. The genetic correlation between nodule density and average nodule size was very high at –0.72 ± 0.25. This correlation may be of value, since the potential to measure nodule density in live birds is greater than that of nodule size. Corresponding figures were –0.33 ± 0.10 for the permanent environmental correlation, –0.17 ± 0.02 for the environmental correlation and –0.28 ± 0.03 for the phenotypic correlation. Nodule size and density were thus negatively correlated at all levels.

Correlations of nodule traits with other easily measurable traits on live ostriches and skins require investigation, since the measurement of nodules to determine average nodule size is a timely process. Subjective evaluation of nodule size, on the other hand, is difficult and often inaccurate, while the objective evaluation of the shape and distribution of the nodules is even more problematic.

Table 3 Variance components and ratios for number of nodules per dm² and nodule size in slaughter ostriches, taken from an overall analysis across all body locations

Variance components and ratios	Number of nodules/dm²	Nodule size (mm)
Components		
Additive variance (σ^2_a)	5.70	0.0134
Animal permanent environment (σ^2_{PE})	19.07	0.0485
Residual (σ^2_e)	33.62	0.0706
Ratios		
h^2	0.10 ± 0.05	0.10 ± 0.05
c^2	0.33 ± 0.05	0.37 ± 0.05

Conclusions

The results of this study do not rule out the possibility of genetic improvement of ostrich skin quality. More research is, however, needed regarding the genetic and environmental aspects of ostrich skin quality to develop a better understanding of skin quality in its totality. Establishing the relative importance of the respective nodule characteristics (size, shape and distribution) and finding objective methods of evaluating them, is another challenge that needs to be addressed. Further investigations into aspects such as genetic variation within localities on the skin and genetic correlations with other easily measurable slaughter traits is also needed for the future development of a system that can exploit the significant genetic variation found in this study. The integration of these in a well-structured breeding plan should be a major objective for the genetic improvement of ostriches.

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