Evaluation of subjectively assessed nodule traits of ostrich skins as influenced by slaughter age

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Abstract

Ostrich skins (n = 214) were assessed by 28 participants involved in the ostrich leather production and marketing chain. The participants were from various sectors in the ostrich industry, including producers, skin graders, leather marketers, agents and process managers. Skins were evaluated during two occasions, firstly without any knowledge of slaughter age and thereafter with prior knowledge of slaughter age. Nodule acceptability and distribution for each skin were scored on a linear scale of 1 to 10. Slaughter age, as estimated by the participants during the first evaluation, was regressed on the actual age of the birds at slaughter. The derived regression indicated that actual slaughter age accounted for approximately 46% of the variation found in estimated slaughter age. Nodule acceptability scores generally increased with slaughter age. Average scores of at least moderately acceptability were found only in skins from birds slaughtered at 11 months of age and older. A corresponding trend with increase in slaughter age was found for nodule distribution scores. Between skin variance ratios were comparatively low for nodule acceptability (0.09-0.10, depending on prior knowledge of slaughter age or not) and nodule distribution (0.05-0.06). The between scorer variance ratio was generally higher, exceeding 0.35. Scores for nodule acceptability with or without prior knowledge of the age of individual skins at slaughter were essentially the same, as judged from a near unity covariance ratio between individual skins. A similar trend was observed for nodule distribution score. The need for practical methods for the objective assessment of the acceptability of nodules and ostrich leather quality was expressed.

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Introduction

Leather contributes markedly to the revenue of commercial ostrich farmers, as indicated by Van Zyl (2001). Ostrich leather competes in the luxury market, and is marketed as a unique, high-value product (Cooper, 2001; Adams & Revell, 2003). The occurrence of nodules on the ostrich skin, as a result of feather development, produces the unique appearance of ostrich leather. These nodules contribute markedly to leather quality (Sales, 1999). No formal standards are available to objectively determine either the acceptability or the distribution of these nodules, however, and skins are largely graded according to subjective evaluation. The effect of age at slaughter on average nodule diameter and the number of nodules per dm² of skin has recently been established on an objective basis (Cloete *et al*., 2004; Meyer *et al*., 2004). Both traits are clearly age-dependent, with nodule size increasing and nodule density decreasing with an increase in slaughter age. The latter studies were conducted against the background of allegations that tanneries adopted the assessment of nodule acceptability as part of their grading strategy to control an increasing supply of skins with unacceptably small nodules. This trend was linked to a propensity to slaughter ostriches earlier than the traditional 14 months of age, to minimize costs and risk (Meyer, 2003). The average nodule size allegedly gradually decreased in the broader industry, presumably due to a positive relationship of nodule size with slaughter age (Cloete *et al*., 2004; Meyer *et al*., 2004).

Against this background this study focuses on the subjective evaluation of nodule acceptability and distribution on ostrich skins obtained from birds slaughtered at various ages, as assessed by various role-players throughout the ostrich leather production and marketing chain.

Material and Methods

A total of 214 ostrich skins obtained from birds slaughtered at the Oudtshoorn Experimental Farm was used in the study. The origin of the commercial ostrich flock at the Experimental Farm is well-documented (Van Schalkwyk *et al*., 1996; Bunter, 2002). Ostriches that contributed data to the study were slaughtered at a range of ages, encompassing 4 to 14 months. After slaughter, the skins were processed and chrome crusted according to standard procedures (Meyer *et al*., 2002). The skins were used to assess the acceptability of the nodules for market requirements, as determined through subjective scoring by 28 role-players in the ostrich leather production and marketing chain. These role-players consisted of primary producers (n = 7), skin graders (n = 3), leather marketers (n = 3), agents (n = 11) and people involved in the management of the production and marketing process (managers; n = 4). The scorers were chosen to represent a divergent range of sectors in the ostrich production and marketing chain to ascertain whether the respective perceptions in the industry were compatible.

The skins were numbered individually and randomly placed on evaluation tables. The 28 scorers were asked to score individual skins for nodule distribution and for nodule acceptability for the marketplace. Skins were scored on a linear 10-point scale. In the case of acceptability 1-2 was regarded as highly undesirable, 3-4 as undesirable, 5-6 as moderately acceptable, 7-8 as highly acceptable and 9-10 as excellent. For distribution, 1-2 was regarded as a very poor distribution, 3-4 as poorly distributed, 5-6 as reasonably well distributed, 7-8 as well distributed and 9-10 as excellently distributed. Initially the scorers were asked to assess the skins without prior knowledge of the slaughter age of each bird. At this stage they were also asked to estimate the age of the bird producing the specific skin. The skins were subsequently shuffled and the actual slaughter age was attached to the skin. The evaluation process was then repeated with the scorers knowing the age of the birds at slaughter.

After editing for incomplete records and scores outside the acceptable boundaries, the data set included complete information on 4018 observations consisting of skin identity × scorer identity records. The data were normally distributed (Table 1) with the scorers using the entire allowed range of 1-10 in all instances. The data were thus subjected to standard mixed model analysis of variance procedures. The trade of the scorer (producer, grader, marketer, agent or manager) was treated as a fixed effect in the analysis. Effects of slaughter age were modelled, using a cubic spline (Verbyla *et al*., 1999). Fixed linear and random nonlinear components of the spline were interacted with the trade of the scorer, using ASREML (Gilmour *et al*., 1999). Random deviations from linearity conforming to a smooth trend were initially included in the model. Since these trends were not significant, they were excluded from the final analyses. The random effects of the identity of the skin and that of the scorer (nested within the trade of the scorer) were fitted simultaneously. Two-trait analyses were subsequently done to obtain covariance components and ratios between scores for nodule acceptability and distribution. These covariance components were partitioned in skin identity, scorer identity and residual components. Scores for nodule acceptability and distribution (as obtained with or without prior knowledge of the age of the skin) were also correlated in two-trait analyses, as described above. These (co)variance components were used to obtain estimates of the repeatability of scores particular to specific skins or scorers, as well as the correlations mentioned previously.

Table 1 Descriptive statistics for the traits assessed during the study, as based on 4018 records for each trait. All traits encompassed the maximum allowable score of 1-10

Trait	Mean ± s.d.	Coefficient of variation (%)	Skewness	Kurtosis
Nodule acceptability				
Slaughter age unknown	5.21 ± 1.72	33.0	0.074	-0.306
Slaughter age known	5.24 ± 1.61	30.7	0.040	-0.181
Nodule distribution				
Slaughter age unknown	6.21 ± 1.71	27.5	-0.283	-0.243
Slaughter age known	6.19 ± 1.72	26.2	-0.177	-0.415

Results

When all 4018 observations were considered, the following regression was derived for the relationship between actual slaughter age (independent variable) and estimated slaughter age (dependent variable):

Estimated slaughter age = $3.72 \pm 0.10 + 0.67 \pm 0.01$ actual slaughter age (r = 0.68)

Standard errors follow the intercept as well as the regression coefficient, which were both different from zero ($P < 0.01$). The near linear relationship between actual age and age estimated by the scorers (according to the occupation of the scorer) is evident from Figure 1. Although the trade of the scorer interacted ($P < 0.05$) with the linear and nonlinear components of the spline for age (as indicated by a fair degree of crossing over of lines), a clear increase was discernable for all trades.

Figure 1 The relationship between actual slaughter age and slaughter age predicted by 28 scorers. The figure is presented as the interaction between the trade of the scorer and actual slaughter age. Vertical lines about the means reflect standard errors

Derived coefficients of variation for the traits considered ranged from 26.2 to 33.0% (Table 1). Despite fairly high levels of variation, no evidence of non-normality was evident when derived coefficients for skewness and kurtosis were considered. Negative estimates of kurtosis indicate a relatively flat distribution for all traits. Acceptability scores of skin nodules judged in the absence of knowledge of age increased with an increase in age at slaughter (Figure 2).

Figure 2 Nodule acceptability scores according to actual slaughter age and the trade of the scorers, when assessed without prior knowledge of the slaughter age of individual ostriches. Vertical lines about the means reflect standard errors

Scores of moderate (acceptability 5-6 on the linear scale) were regarded as the minimum standard for acceptability. Based on average scores it was evident that only skins of birds aged 11 months and older would qualify when judged by producers, graders, agents and managers. Compared to other scorers, the marketers appeared to be generally stricter (P < 0.05) as far as scoring for acceptability was concerned. Average scores of even the oldest birds barely reached the minimum requirement for acceptability according to their assessment. The trade of the scorer once again interacted (P < 0.05) with the linear and nonlinear components of the spline for slaughter age. The general tendency, however, reflected an increase in nodule acceptability with age for all trades. From this perspective overall trends for nodule acceptability were compared with or without information on age (Figure 3). The same basic trend was observed, although scorers tended (P < 0.10) to award higher scores for nodule acceptability for skins of birds slaughtered at 11 months of age when the slaughter age was known.

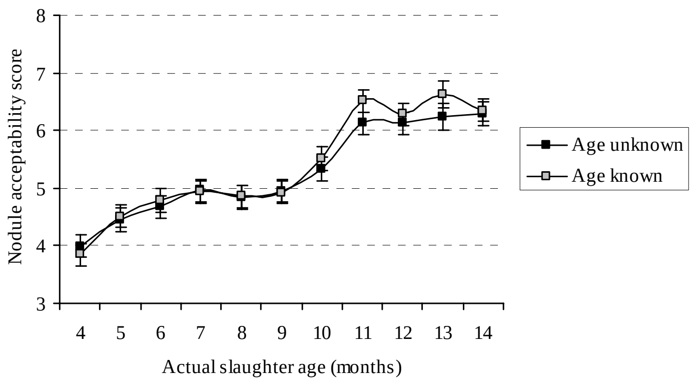

Figure 3 Mean nodule acceptability scores according to actual slaughter age for all scorers, with or without prior knowledge of the slaughter age. Vertical lines about the means reflect standard errors

Scores for overall nodule distribution also showed a general increase (P < 0.05) with an increase in slaughter age. The trade of the scorer interacted (P < 0.05) with the linear and nonlinear components of the spline for slaughter age (Figure 4).

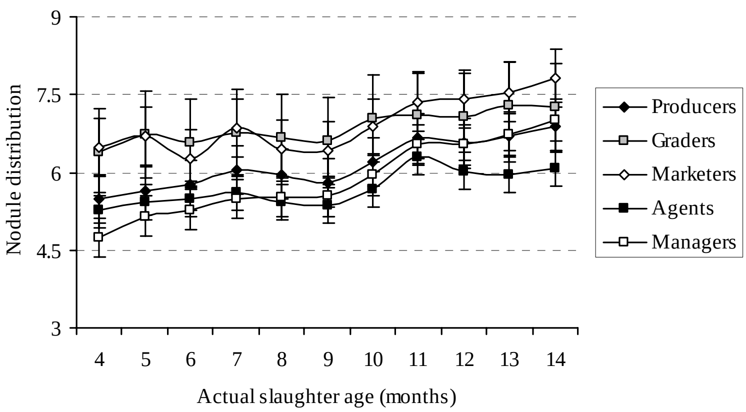

Figure 4 Nodule distribution scores according to actual slaughter age and the trade of the scorers when assessed without prior knowledge of the slaughter age. Vertical lines about the means reflect standard errors

At young ages there was a suggestion for nodule distribution scores awarded when age was known to be below scores awarded when age was unknown (Figure 5). The converse was true at high ages, culminating in a tendency (P < 0.10) towards a higher nodule distribution score when slaughter age was known at 13 months.

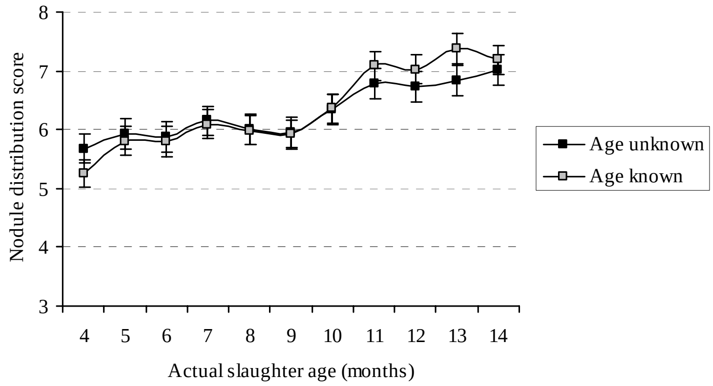

Figure 5 Mean nodule distribution scores according to actual slaughter age for all scorers, when assessed with or without prior knowledge of the slaughter age of individual skins. Vertical lines about the means reflect standard errors

The between skin variance components were fairly low, leading to repeatability estimates (± s.e.) of 0.10 ± 0.02 and 0.09 ± 0.02 for nodule acceptability score with and without prior knowledge of slaughter age. Corresponding estimates for nodule distribution score were 0.06 ± 0.01 and 0.05 ± 0.01, respectively. Between scorer variance ratios were higher, respectively 0.37 ± 0.07 and 0.43 ± 0.07 for nodule acceptability and 0.43 ± 0.07 and 0.45 ± 0.07 for nodule distribution. Repeatability results obtained from two-trait analyses were in all cases similar to, or within 0.01 of those derived from one-trait analyses. The between individual skin correlation between nodule acceptability and nodule distribution approached unity when age at slaughter was unknown (0.94 ± 0.03), and exceeded unity when age at slaughter was known (1.04 ± 0.03). Estimates of the between scorer correlation were somewhat lower at 0.54 ± 0.15, irrespective of whether slaughter age was known or not. The residual correlation amounted to 0.45 ± 0.01 when slaughter age was unknown and to 0.41 ± 0.01 when slaughter age was known. When correlations between nodule acceptability with or without prior knowledge of age were partitioned, the between individual skin component was estimated at 0.93 ± 0.03, the between scorer component at 0.77 ± 0.09 and the residual component at 0.25 ± 0.02. Corresponding correlations between nodule distribution with or without prior knowledge of slaughter age were 0.97 ± 0.04, 0.87 ± 0.05 and 0.26 ± 0.02, respectively.

Discussion

The regression of estimated age of the bird at slaughter on actual slaughter age was significant (P < 0.01). The scorers were thus able to estimate age at slaughter to a fair degree, based on the physical appearance of the tanned skin. However, variation in the dependent variable (actual slaughter age) only accounted for approximately 46% of the variation in estimated slaughter age. A very accurate linear regression equation in this instance would have had a slope of one and an intercept of zero. This clearly was not the case in the present study, the slope being below one and the intercept being above zero (P < 0.01 in both cases). In very young birds, slaughter age was generally estimated higher than the actual age. The accurate prediction of age at slaughter, as based on the appearance of the nodules on the skin, was thus not possible. A general relationship between the two variables did, however, prevail. This result suggested that the scorers were able to respond to visual and/or tactile cues on the skin that assisted them in the estimation of slaughter age, although the relation was imperfect.

The acceptability of the nodules for the marketplace (as perceived by the scorers) improved with an increase in age at slaughter. It was also demonstrated that nodule size measured objectively on ostrich skins also increased with slaughter age (Cloete *et al*., 2004; Meyer *et al*., 2004). The relative contribution of nodule size and nodule shape to nodule acceptability needs to be investigated further. The occurrence of nodules on ostrich skins produces the unique character of this specific type of leather, and it can therefore be expected that the size and shape of these nodules will play a role in the acceptability of ostrich leather in the marketplace.

Scorers from all trades recorded an increase in nodule acceptability with age at slaughter, but average scores given by marketers appeared to be more conservative than those given by the other leather trade representatives. This trend could be merely coincidental, since the means were obtained from the inputs of only three marketers. Alternatively, it could be speculated that marketers are intent on delivering a quality product to the next role-player in the marketing chain, resulting in them being stricter on a quality trait such as nodule acceptability than the scorers from other sectors of the marketing chain. This contention is, however, purely speculative and requires verification in further studies.

Scores for nodule distribution also improved with age, irrespective of the trade of the scorer. When nodule density was assessed objectively it was found that the number of nodules per dm^2 decreased with an increase in slaughter age (Cloete *et al*., 2004; Meyer *et al*., 2004), implying that the average distance between nodules increased correspondingly. It seems therefore that assessment of nodule distribution was based on the proportional distribution of the nodules, and was not related to nodule density.

Knowledge with regard to the age at slaughter of individual skins did not result in marked changes in the derived age trends for nodule acceptability score or nodule distribution score. It thus seems as if the scorers assessed these two traits *per se*, without being unduly influenced by prior knowledge of the age of the individual birds at slaughter. The scorers did, however, tend to award higher scores for nodule acceptability to skins from birds slaughtered at 11 months and older when age was known, compared to when age was unknown. It is possible that preconceived notions in the ostrich industry could have influenced these scores, since a slaughter age of 11-12 months is widely being regarded as the minimum for achieving good skin grading results, while also saving on feed costs.

Both nodule acceptability and nodule distribution were essentially the same trait when assessed either in the presence or in the absence of knowledge on the age at slaughter of individual skins, as reflected by near unity between skin correlations. These results imply that, overall, average scores allocated to specific skins were markedly consistent. On the level of individual assessments made by scorers there appear to be higher levels of inconsistency, as reflected by markedly lower residual correlations amounting to only approximately 0.25. The distribution of the nodules, as assessed in the present study, seemed to closely reflect nodule acceptability. As a matter of fact, nodule acceptability score and nodule distribution score was essentially the same trait on an individual skin or animal level, as reflected by between individual correlations approaching or exceeding unity. In view of this evidence it is debatable whether the industry representatives undertaking the scoring were able to differentiate clearly between the two traits.

Ideally, the between individual skin variance ratio would be expected to be high, indicating that specific skins were consistently allocated high or low scores by the bulk of the scorers (Roux, 1961). The between scorer variance ratio would be correspondingly low, indicating that the average scores allocated by all the scorers regressed back to a common mean, without some scorers being unduly conservative or liberal in their assessment of individual skins. This is clearly not the case, since the between skin variance ratio was 10% or lower, while the between scorer variance ratio exceeded 35% in all cases. These results imply that the linear scale was not applied consistently by all the scorers. This is, however, not uncommon when traits are assessed subjectively in the animal sciences. In the study of Roux (1961), final year agricultural diploma students scored sheep according to Merino breed standards. The between sheep variance ratio in this study was 0.10, and the between scorer variance ratio 0.37. These results thus resembled closely those obtained in the present study. Roux (1961) emphasized the importance of a well-defined description of the subjective trait under assessment in studies of this nature. In the present study, the experience of the participants in the ostrich leather industry was assumed to be sufficient for consistence in their assessment, and no attempt was made to standardize their scores. Reflecting back, this was probably not the correct strategy. A number of studies on various livestock species indicated that well-defined subjective traits were scored very consistently when facilitated by aids like photographic standards. Individual scores for body plumage of layers were highly correlated between two experienced scorers, using a photographic standard as aid (0.87-0.94; Tauson *et al*., 1984). Mean scores for the extent of udder oedema in dairy heifers of test scorers were closely related to that of an official scorer when using a graphic aid developed by the latter (0.94; Tucker *et al*., 1992). Correlations pertaining to individual test scorers in relation to the official scorer were also high, ranging from 0.86 to 0.92. These examples serve to illustrate that the consistence of subjective scores can be improved upon by the provision of photographic or graphic aids. The development of a corresponding aid for the assessment of skin nodules should thus be considered.

Conclusions

The study indicated that nodule acceptability and nodule distribution scores on ostrich skins increased with slaughter age. It remains to be seen whether the increase in nodule acceptability score with an increase in slaughter age is mediated by the age-related change in nodule size of ostrich skins that is reported in the literature. Subjective assessment by the various role-players in the production and marketing chain of the ostrich industry was not very consistent, as indicated by fairly low between skin variance ratios. Alternative evaluation procedures need to be considered to allow a greater measure of objectivity in the evaluation process. Such a development is likely to benefit all the participants throughout the ostrich leather production and marketing chain by adding consistency to the evaluation of skin quality by various participants.

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