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AN APPROACH TO CONNECT MULTI-TRAIT MIXED MODEL AND PRINCIPAL COMPONENT ANALYSIS FOR DESCRIBING VARIATION IN CARCASS QUALITY OF CROSSBRED CATTLE

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SUMMARY

A principal component analysis of the 4×4 sire, maternal, management and environmental (co)variance matrices derived from a multi-trait sire model was conducted to describe variability in four economically important carcass traits. Carcass weight (HCWt), P8 fat (P8), eye muscle area (EMA) and intramuscular fat (IMF) collected from 1144 heifers and steers calves from seven sire breeds: Angus, Belgian Blue, Hereford, Jersey, Limousin, South Devon and Wagyu, born over a 4-year period. The first two principal components (PC1, PC2) accounted for 90% of the total variance in the considered variables, except for the maternal component, where PC1 and PC2 accounted for 83% of the total variance. The largest and the least variations attributed to the management (99%) and maternal (83%) components, respectively. Sire and environment components showed similar patterns of eigenvector coefficients for the first two vectors. The first and second eigenvectors have large loadings for P8 fat and IMF, respectively. The third orthogonal vector had a large coefficient for the HCWt and EMA but not other traits. For the maternal component, which is a small component of overall variation, P8 fat in contrast to IMF had a significant relationship with the PC1. PC1 could be defined as a fat distribution component. PC2 respects mean values for carcass traits with less attention to EMA, presenting market suitability. For management component as the largest component of overall variation, PC1 could be interpreted as a weighted mean with much more emphasis on the IMF. PC2 accounting, for 25.78% of the total variance, indicated a major contrast between P8 and IMF, consequently it can be interpreted as a fat distribution component.

Keywords: Principal component analysis, Multivariate, Sire model, Carcass traits

INTRODUCTION

In two components papers by Mirzaei *et al.* (2009) multi-trait mixed model and principal component analysis (PCA) have been conducted to examine of variation in carcass traits. PCA of raw data is a useful exploratory tool but lacks adjustment for fixed effects (e.g., breed and sex). Thus, the correlation structure and variation involving these traits should be regarded with caution. Hence, it is worthwhile conducting principal component analysis on estimated (co)variance structures for sire, maternal, management and environment obtained from multi-trait mixed model with the hope of obtaining quality information. The aim of this paper is to investigate the decomposition of a square matrix (4×4) of the sire, maternal, management and environment into eigenvalues and eigenvectors (PCA) for the four carcass traits obtained from multi-trait mixed model. The determination of the eigenvectors and eigenvalues of those components aids in understanding the important sources of variation in carcass quality traits and to realize that how fitting fixed factors affect linear combinations of the original variables.

MATERIALS AND METHODS

Data were obtained from the Southern Crossbreeding Project which was designed for meeting a range of market specifications. Mature Hereford cows (581) were mated to semen from 97 sires from seven breeds (Angus, Belgian Blue, Hereford, Jersey, Limousin, South Devon and Wagyu), resulting in 1144 live calves born over 4 years (1994-97). All statistical analyses were conducted using PROC PRINCOMP (SAS Institute Inc. 1999).

A multi-variate sire model was fitted using ASREML (Gilmour *et al.*, 2000), estimating multi-trait (co)variance components including genetic and non-genetic parameters of carcass quality traits (Table 1). Variation in the four carcass quality traits (HCWt, P8, EMA and IMF) was considered in terms of the same fixed and random factors as the growth models. Principal component analysis of the 4×4 (co)variance matrices derived from the above multi-trait carcass model for sire (¼ additive genetic as effectively nested within breed), maternal (¼ additive genetic + maternal genetic + dam permanent environmental effect), management group (combination of sex, year and pre- and post-weaning cattle management group) and environmental (residual). The model is : $\mathbf{PC_n} = X\boldsymbol{\tau} + Z\mathbf{u} + \mathbf{e}$ where $\boldsymbol{\tau}$ is the vector of fixed effects, $\mathbf{u}$= vector of random effect, $\mathbf{e}$ = vector of random residual effect (temporary environmental effect or measurement error), **NID (0, σ^2)**.

RESULTS

PCA results herein permit a description of the simultaneous or multivariate patterns of covariation among the various carcass quality traits within each variance components. These eigenvectors were orthogonally rotated to facilitate more interpretable results, i.e. statistically independent vectors exhibiting either high or low eigenvector coefficients or few intermediate values. The four patterns of co-variation (eigenvectors) summarize the common information among these four carcass quality traits. In general, sire correlations between carcass traits were variable, dam and management correlations were high and environmental (residual) correlations were low.

The first two principal components accounted for the major proportions of the total variation in four components (83-99%, Table 1).

For sire, management and environment (residual), PC1 was related to fatness with the eigenvector was positive for both P8 fat depth and IMF (Figure 1). PC2 was related to fat distribution with opposite weightings for P8 fat and IMF. The maternal component was quite different in that PC1 could be described as fat distribution and PC2 as growth since the Eigen vector had positive weightings for all four carcass traits. Coefficients for the remaining traits were small and contribute little to those eigenvectors.

DISCUSSION

Overall, the first two principal components accounted for much variation in carcass traits and quite obviously correlated with fat traits (P8 and IMF) reflecting relatively high correlations between the four carcass traits. While the results herein are scientifically interesting, for four traits it is difficult to see large benefit in using principal component analysis. However, it could be beneficial for summarizing larger numbers of traits and potentially for describing bull “types” which is common in stud sale catalogues.

REFERENCES

Gilmour. A.R., Bulls. B.R., Welham. S.J. and Thompson. R. (2000). Orange Agricultural Institute. Forest Road. Orange 2800 NSW Australia.

Mirzaei. H.R., Verbyla. A.P., Deland. M.P. and Pitchford. W.S. (2009) *Pak J Biol Sci.* **12:** 222.

SAS, (1999). SAS/STAT User’s Guide. Fourth edition, Cary, N.C. : SAS Institute

Burrow. H.M. (2012). *Animal.* **6:** 729.

Table 1. The eigenvalues and eigenvectors (PCs) of the sire, maternal, management and environmental correlation matrices for carcass traits

	PC1	PC2	PC3	PC4
Sire				
HCWt	-0.05	-0.03	**0.79**	**0.61**
P8	**0.94**	-0.33	0.08	-0.05
EMA	-0.13	-0.11	**0.60**	**-0.78**
IMF	0.32	**0.94**	0.12	-0.09
%variance	65	27	7	1
Maternal				
HCWt	0.12	**0.54**	**0.50**	**0.66**
P8	**0.59**	**0.61**	**-0.46**	-0.26
EMA	0.15	0.12	**0.72**	**-0.67**
IMF	**-0.79**	**0.56**	-0.13	-0.22
%variance	51	32	13	4
Management				
HCWt	0.16	-0.13	-0.05	**0.98**
P8	0.22	**-0.93**	-0.25	-0.17
EMA	0.15	-0.22	**0.96**	0.00
IMF	**0.95**	0.27	-0.09	-0.13
%variance	74	26	0	0
Environment				
HCWt	0.07	0.01	-0.42	**0.91**
P8	**0.94**	-0.34	0.04	-0.05
EMA	0.02	-0.01	**-0.91**	-0.42
IMF	0.34	**0.94**	0.01	-0.03
%variance	53	39	7	2

Values in bold indicate high loading values

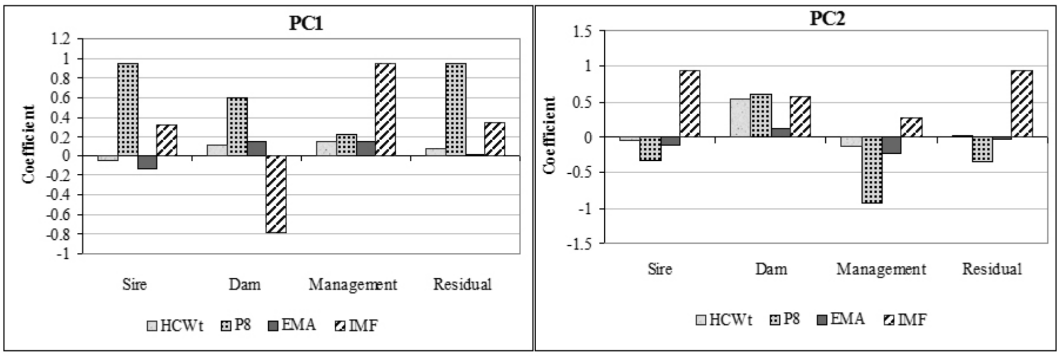

Figure 1. Loading comparisons of the first two principal components