

The Genetic Parameters for Average Daily Gain and Kleiber Ratio in Aberdeen Angus Breed

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Abstract

The objective of this paper was to estimate the genetic parameters for average daily gain from birth to 200 days and Kleiber ratio in Aberdeen Angus breed with maternal animal model. The data were represented by 1206 records from Aberdeen Angus breed. The pedigree was formed from 2563 cattle: 154 sire, 1203 dams and 1206 cattle with performances. The data were obtained from Aberdeen Angus Association. The direct breeding value of cattle ranged between -0.401 and 0.772 for average daily gain and maternal breeding value between -0.191 and 0.243. The direct breeding value of cattle for Kleiber ratio ranged between -0.370 and 0.347 and maternal breeding value between -0.164 and 0.123. The direct heritability for average daily gain from birth to 200 days was 0.218, the maternal heritability 0.082 and the total heritability 0.200. The direct heritability for Kleiber ratio was 0.219, the maternal heritability 0.081 and total heritability 0.200.

Keywords: average daily gain, beef breed, Kleiber ratio, maternal animal model

1. Introduction

The profitability of beef production depends the feed efficiency. Aberdeen Angus breed has a good conversion of the forage. The objective of the breeding program of the Aberdeen Angus was the improvement the growth traits for increase meat production, to increase quality of beef production, to develop a genetically valuable nucleus and recognized worldwide. It is desired to obtain a birth weight of 35kg, average daily gain between birth and weaning of 900 g for females and 1000 g for males, weaning weight for heifers 220 kg and for bulls 260 kg. Development of the program breeding is carried out so that the Aberdeen Angus breed evolves in the direction of the coming requirements from farmers. The Aberdeen Angus breed is the most widespread and appreciated beef

cattle breed in the world. It is adapted to the pedoclimatic conditions from our country. The official performance control is carried out according with international regulations established by ICAR commission and the aims is to improve farm management and the genetic evaluation of cattle record. The aim of this study was the estimation the genetic parameters for average daily gain from birth to 200 days and Kleiber ratio in Aberdeen Angus breed with maternal animal model for selection.

2. Materials and methods

The data were represented by records of 1206 cattle. The pedigree consisted in 1206 cattle with records, 1203 dams and 154 sire from Aberdeen Angus breed. The data were from Aberdeen Angus Association for beef cattle.

The estimation of variance components and genetic parameters was performed based on script [1] using maternal animal model with the software R 3.5.1

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The maternal animal model was (Mrode and Thompson, 2005) [2]:

$$y = Xb + Za + Wm + Spe + e$$

y = the vector of observations,
 b = the vector of the fixed effects,
 a = the vector of the random animal effects,
 m = the vector of the random maternal genetic effects,
 pe = the vector of the permanent environmental effects and
 e = the vector of the random residual effects.

X, Z, W and S are the incidence matrices referring to animal performance, to the fixed effects, to the direct effects, the maternal effects and to the permanent environmental effects.

It is assumed that:

$$\text{var} \begin{bmatrix} a \\ m \\ pe \\ e \end{bmatrix} = \begin{bmatrix} \sigma_a^2 A & \sigma_{am} A & 0 & 0 \\ \sigma_{am} A & \sigma_m^2 A & 0 & 0 \\ 0 & 0 & I\sigma_{pe}^2 & 0 \\ 0 & 0 & 0 & I\sigma_e^2 \end{bmatrix}$$

where:

A is the kinship matrix between animals;
 I is the identity matrix;
 σ_a^2 is the additive genetic variance for the direct effects,
 σ_m^2 , the additive genetic variance for the maternal effects,
 σ_{am} , the additive genetic covariance between the direct and maternal effects,

σ_{pe}^2 , is the variance due the permanent environmental effects,
 σ_e^2 , is the variance of the residual error.

According to the objective of this paper the following genetic parameters were estimated:

- the direct heritability $h_a^2 = \sigma_a^2 / \sigma_p^2$, where σ_p^2 is the phenotypic variance
- the maternal heritability $h_m^2 = \sigma_m^2 / \sigma_p^2$
- the covariance between direct and maternal effects as proportion of the phenotypic variance (σ_{am} / σ_p^2)
- the total heritability (Wilham et al., 1972) [3]

$$h_T^2 = \frac{\sigma_a^2 + 0.5\sigma_m^2 + 1.5\sigma_{am}}{\sigma_p^2}$$

where:

h_T^2 is the total heritability, and σ_p^2 is the phenotypic variance

The Kleiber ratio at 200 days was calculate with formula

$$KR_i = ADG / BW^{0.75} * 100$$

ADG= average daily gain observed between initial weight- birth weight and the weight at 200 days
 BW= the body weight at 200 days

3. Results and discussion

In table 1 were presented the statistics for growth traits, average daily gain and Kleiber ratio for Aberdeen Angus cattle.

Table 1. The descriptive statistics for the studied traits

Trait	Mean ±standard error	Standard deviation	Coefficient of variability (%)
Birth weight (kg)	29.954±0.142	4.952	16.53
Weight at 200 days (kg)	219.007±1.272	44.179	20.17
Average daily gain (kg/day)	0.945±0.006	0.223	23.66
Kleiber ratio (kg/kg ^{0.75})	1.645±0.004	0.146	8.914
Metabolic live weight at 200 days (kg)	56.718±0.245	8.529	15.037

The growth traits depend by the breed, individual, nutrition. The average daily gain of calves from birth to weaning depends the milk production of cows.

Mădescu et al. (2022) reported a mean of 184.3 kg at 7 months and average daily gain 799g/day in Aberdeen Angus population.

Bissembayev et al. (2023) reported the value for birth weight in Aberdeen Angus 28.25 kg for males and 27.18 kg for heifers and for weaning weight 212.31 kg for bulls and 198.04 for heifers and for average daily gain from birth to 210 days 879.56 g for bulls and 847 g for heifers from Aberdeen Angus breed lower that the values obtained in our study. Forster et al. reported

higher mean for birth weight than in our study 34.58 kg, 33.69 kg for female and 34.66 kg for males.

Nikolov et al. (2020) reported 31.6 kg for female calves at birth, Jakubec et al. (2003) 29.22 and Kolisnyk 26.5 kg for females and 29.4 kg for males. For average daily gain in the first three months 0.700-0.750 kg in the first three months and 0.830-0.950 kg during 4-7 months was reported by Nikolov et al. (2020). At 210 days Jakubec et al. (2003) reported the mean weight 241.42 kg higher than in our study.

The direct breeding value of cattle from our study ranged between -0.401 and 0.772 for average daily gain and maternal breeding value ranged between -0.191 and 0.243.

The direct breeding value of cattle for Kleiber ratio ranged between -0.370 and 0.347 and maternal breeding value ranged between -0.164 and 0.123. The direct breeding value for the best cattle was presented in the table 3. The maternal breeding value of the best cows for average daily gain and Kleiber ratio was presented in the table 4.

The genetic parameters for average daily gain from birth to 200 days and Kleiber ratio were shown in table 5. Schenkel et al. (2004) reported the heritability for average daily gain 0.35. Crowley et al. (2010) reported the heritability for average daily gain from 10 months to 12 months 0.27 and for Kleiber ratio 0.24 and maternal heritability 0.03 for average daily gain and 0.06 for Kleiber ratio. Khobondo et al. (2022) reported direct heritability for average daily gain at 205 days 0.27 and for Kleiber index at 205 days 0.13 in beef cattle. Matos et al. (2019) obtained a value of direct heritability for the average daily gain from birth to 205 days 0.21 and maternal heritability 0.05 in Brahman cattle breed and for Kleiber ratio direct heritability 0.19 and maternal heritability 0.04. Mehrban et al. (2021) obtained the heritability for Kleiber ratio 0.28. Koster et al. (1994) reported heritability for Kleiber ratio from birth to 205 days 0.218 in Hereford herd. El-Saied et al. (2006) reported the direct heritability for pre-weaning daily weight gain was 0.22 and maternal heritability 0.18 in Charolais breed.

Table 2. The average performances for growth traits, average daily gain and Kleiber ratio for females and males

No.	Birth weight	Weight at 200 days	Average daily gain (kg)	Metabolic body weight	Kleiber ratio
Mean ±standard error for females	29.780±0.176	213.079±1.630	0.916±0.008	55.569±0.315	1.628±0.089
Standard deviation	4.634	42.862	0.218	8.278	0.145
Coefficient of variability (%)	15.562	20.115	23.862	14.897	8.905
Mean ±standard error for males	30.188±0.235	226.961±1.970	0.983±0.009	58.261±0.380	1.668±0.006
Standard deviation	5.344	44.709	0.224	8.624	0.146
Coefficient of variability (%)	17.704	19.699	22.838	14.803	8.75

Table 3. The direct breeding value of the best cattle for average daily gain and Kleiber ratio in Aberdeen Angus breed

No.	Direct Breeding value of cattle for Average daily gain (kg)	Direct breeding value of cattle for Kleiber ratio
1	0.772	0.347
2	0.750	0.330
3	0.749	0.329
4	0.678	0.325
5	0.542	0.304
6	0.498	0.256
7	0.481	0.249
8	0.474	0.245
9	0.441	0.240
10	0.432	0.238

Table 4. The maternal breeding value of the best cattle for average daily gain and Kleiber ratio in Aberdeen Angus breed

No.	Maternal breeding value of cattle for average daily gain (g)	Maternal breeding value of cattle for Kleiber ratio
1	0.243	0.123
2	0.227	0.106
3	0.221	0.102
4	0.215	0.095
5	0.208	0.090
6	0.175	0.089
7	0.172	0.088
8	0.165	0.076
9	0.139	0.075
10	0.133	0.074

Table 5. Estimates of (co)variance components and genetic parameters for average daily gain and Kleiber ratio for Aberdeen Angus cattle breed

Item	Average daily gain	Kleiber ratio
σ_a^2	0.0129	0.054
σ_m^2	0.0048	0.002
σ_{am}	-0.002	-0.0009
σ_{pe}^2	0.034	0.0145
σ_e^2	0.004	0.0019
σ_p^2	0.059	0.024
c^2	0.576	0.604
σ_{am}/σ_p^2	-0.033	-0.037
h_a^2	0.218	0.219
h_m^2	0.082	0.081
r_{am}	-0.293	-0.294
h_T^2	0.200	0.200

Table 6. The genetic correlation for average daily gain and Kleiber ratio

Item	The genetic correlation between direct breeding values	The genetic correlation between maternal breeding values
Average daily gain	0.985	0.989
Kleiber ratio		

4. Conclusions

Aberdeen Angus breed had high average daily gain and Kleiber ratio from birth to 200 days. The direct heritability for average daily gain and Kleiber ratio was moderate. The genetic correlation between direct breeding values of cattle and maternal breeding values for average daily gain and Kleiber ratio was very high. For improvement feed efficiency and meat production in Aberdeen Angus breed must to select the cattle with the best breeding values for average daily gain and Kleiber ratio.

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References

- Grosu, H., Oltenacu, P.A., Breeding programs in Animal Husbandry. Ceres Publishing House Bucharest, RO, 2005.
- Mrode, R.A., Thompson, R., Maternal Trait Models: Animal and Reduced Animals Models. In: Linear

models for the Prediction of Animal Breeding Values. Cabi Publishing UK., 2005, pp. 121-134.

3. Wilham, R.L., The role of maternal effects in animal breeding. Biometrical aspects of maternal effects in animals. *J. Anim. Sci.*, 1972, 35, 1288-1293.

4. Mădescu, B.M., Lazăr, R., Davidescu, M.A., Matei, A.C., Boișteanu, P.C., Research on morpho-productive indicators observed of Aubrac and Aberdeen Angus cattle breeds, *Scientific Papers. Series D. Animal Science*, LXV, 2, 2022, 279-283.

5. Bissembayev A.T., Shamshidin A.S., Kasenov Z.M., Chindaliyev A.E., Starostina O.S., Baranova I.A., Batanov S.D., Nazarbekov A.B., Baimukanov D.A. Estimated breeding values of Aberdeen-Angus cattle breed, *Online Journal of Biological Sciences*, 2023, 23,3, doi: 10.3844/ojbsci.2023.351.360.

6. Forster K.M., Pimentel M.C., Moraes J.C.F. Availability of net energy in the milk and weight performances in Hereford and Aberdeen Angus calves from birth to weaning, *Revista Brasileira de Zootecnia*, 2010, 39, 11, 2545-2552.

7. Nikolov, V., Karamfilov, S., Growth of female calves of the Aberdeen Angus cattle breed reared in an organic farm, *Scientific Papers. Series D. Animal Science*, 2020, LXIII, 1, 60-66.

8. Kolisnyk, O. I., Prudnikov, V. G., Kryvoruchko Yu, I., Monitoring and evaluation of the meat diseases of the Aberdeen-Angus breed in Ukraine, *Bulletin of Poltava State Agrarian Academy, UA*, 2018, 3, 127-131.

9. Jakubec, V., Schlote, W., Rika, J., Majzlik, J., Comparison of growth traits of eight beef cattle breeds in the Czech Republic. *Arch. Tierz*, 2003, 46, 2, 143-153.

10. Schenkel, F.S., Miller, S.P., Wilton, J.W., Genetic parameters and breed differences for feed efficiency,

growth, and body composition traits of young beef bulls. *Canadian J. Animal Science*, 2004, 82, 2, 177-185.

11. Crowley, J.J., Mc Gee, M., Kenny, D.A., Crews Jr, D.H., Evans, R.D., Berry, D.P., Phenotypic and genetic parameters for different measures of feed efficiency in different breeds of Irish performance-tested beef bulls. *Journal of Animal Science*, 2010, 88, 885-894.

12. Khobondo J., Muasya, D. T., Fixed effects and genetic parameters on feed efficiency and growth traits of Boran cattle in Kenya, *Egerton University International Conference*, 2022. <https://conferences.egerton.ac.ke/index.php/euc/article/view/194>

13. Matos, M., Cavani L., Millen D.D, Andrighetto C, Lupatini GC, Da Fonseca R., Estimation of genetic parameters for weight traits and Kleiber index in a Brahman cattle, *Scientia Agricola*, 2019, 76, 6, 459-462.

14. Mehrban, H., Naserkheil, M., Lee, D.H., Ibáñez-Escriche, N. Genetic parameters and correlations of related feed efficiency, growth, and carcass traits in Hanwoo beef cattle. *Anim. Biosci.* 2021, 34, 5, 824-832.

15. Koster, E., Van der Westhuizen, J., Erasmus, G.J., Heritability estimates for different Kleiber ratio obtained from growth performance data in A Hereford herd. *S.Afr. J. Anim. Sci.* 1994, 24, 2, 71-72.

16. El-Saied, U.M., Fuente, L.F., Rodríguez, R., San Primitivo, F., Genetic parameter estimates for birth and weaning weights, pre-weaning daily weight gain and three type traits for Charolais beef cattle in Spain. *Spanish Journal of Agricultural Research*, 2006, 4, 146-155.