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MATERNAL COMPONENTS AS RELATED TO DIRECT COMPONENTS FOR SOME GROWTH TRAITS OF FRIESIAN CALVES IN EGYPT

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ABSTRACT

Records of growth traits from birth to weaning on 1713 Friesian calves (813 males and 900 females) daughters of 703 dams and 93 sires during the period from 1982 to 2001 at Sakha and El-Karada farms were used in the analysis. (Co)variance components were estimated with REML using an animal model that included the fixed effects of month and year of birth, sex, farm and birth sequence. Random effects were animal, direct and maternal genetic effects, maternal permanent environmental effect and random effect. Weight of dam at calving was included in the model as a covariate. Direct and maternal genetic effects and other parameters for birth weight (BW), weaning weight (WW) and daily gain (DG) from birth to weaning were estimated. Overall means and standard deviations for BW, WW and DG were 30.8 ± 5.1 kg, 96.5 ± 10.2 kg and 547 ± 89 g/day, respectively. Direct heritability of the mentioned traits was 0.32, 0.34 and 0.37, respectively. Heritabilities of maternal effects of BW (0.17), WW (0.14) and DG (0.09) were smaller than direct heritabilities. Estimates of permanent environmental variance as a proportion of phenotypic variance were 0.12, 0.08 and 0.04 for BW, WW and DG, respectively. Estimates of direct-maternal genetic correlations in all traits studied were negative ranging from -0.59 to -0.02. Genetic and phenotypic correlations between BW and DG were small and negative, -0.14 and -0.22, respectively, while genetic and phenotypic correlations between WW and DG were high and positive, 0.84 and 0.93, respectively.

Keywords: Growth traits, Friesian calves, Maternal effect, Direct effect, Direct heritability and Direct-maternal genetic correlations.

INTRODUCTION

In Egypt, Friesian cattle are the most widespread exotic dairy cattle and considered as potential dual-purpose for milk and meat production. A large number of male Friesian calves are slaughtered annually to fill the great gap in meat production. Growth performance (e. g. birth weight, weaning weight and growth rate) is affected by genetic and environmental factors, in addition to maternal effect. Maternal effects have been defined as any influence resulting from a dam on its offspring, excluding the effects of directly transmitted genes that affect performance of the offspring (Legates, 1972).

Maternal effect is expressed through the environment that a dam avails to her progeny, pre- and post-natally. There are also the genes that are passed onto the dam's progeny affecting the environment that the female progeny provide for their offspring. Weaning and pre-weaning weights partially express the calf rearing ability of a cow beside the calf own genotype. The aim of this study was to estimate additive and maternal genetic effects and their relationship between them for birth weight (BW), weaning weight (WW) and daily gain (DG) from birth to weaning of Friesian calves in Egypt.

MATIRIALS AND METHODS

Data and managements

The data used in this study were taken from the records of the Friesian calves in Sakha and El-Karada farms, located in the northern part of middle Delta, during the period 1982 to 2001. These herds belong to the Animal Production Research Institute, Ministry of Agriculture, Egypt. A total of 1713 Friesian calves (813 males and 900 females) born from 703 cows mating by 93 sires were used in analysis. The same sires were used in the two farms.

Omar (1984) described housing, feeding and management of the Friesian cattle in these stations. After birth, calves were left with their dams to suckle colostrum for the first three days of their life. Then, they were removed from their dams and housed individually in calf pens bedded with rice straw till weaning at (sixteen weeks of age). During this period calves were artificially reared on natural milk provided in pails according to their weight. At the third week of their age and up to 16 weeks, concentrates ration (calf meal) and berseem hay (*Trifolium alexandrinum*) were offered to calves according to Animal Production Research Institute (APRI) system. The contents of the calf meal were 48% yellow maize, 17% seed cotton cake, 10% wheat bran, 10% rice starch residue, 10% linseed meal, 2% molasses, 1% limestone, 1% bone meal and 1% salt (sodium chloride). After reaching sixteen week of age, the calves were loosely housed in open sheds where they can easily eat, drink and exercise. Birth weights were taken on calves within 24 hours from birth, weaning weight at 16 weeks of age and daily gain from birth to weaning calculated as the weight at weaning minus weight at birth divided by the number of days between them.

Statistical Analysis

Data were analyzed with the MTDFREML program according Boldman *et al.*, (1995) using multiple trait analysis animal model. Effects of year and month of birth, sex of calf, farm and parity (birth sequence) were assumed to be fixed. Body weight of cow at calving as covariate and effects of animal, direct and maternal genetic effects, maternal permanent environmental effect and random residual effect considered being random. In multiple traits animal model the full general model used was:

$$Y = Xb + Za + Mm + Wp_e + e$$

Where:

Y = observations vector of records, b = the vector of fixed effects (level of month of birth, year of birth, sex, farm and birth sequence), a = the vector of direct genetic effects, m = the vector of maternal genetic effects, p_e = the vector of environmental effects contributed by dams to records of their progeny (permanent environmental), and e = the vector of residual effects. X, Z, M and W are incidence matrices relating records to fixed, direct genetic, maternal genetic and permanent environmental effects, respectively.

The variance and covariance structure for the model was as follows:

$$E(y) = Xb \quad \text{and}$$

$$V \begin{bmatrix} a \\ m \\ p_e \\ e \end{bmatrix} = \begin{bmatrix} A\sigma^2_a & A\sigma_{am} & 0 & 0 \\ A\sigma_{am} & A\sigma^2_m & 0 & 0 \\ 0 & 0 & I_d\sigma^2_{pe} & 0 \\ 0 & 0 & 0 & I_N\sigma^2_e \end{bmatrix}$$

Where:

d is the number of dams and N is the number of records, A is the numerator relationship matrix between animals, σ^2_a is the additive direct genetic variance, σ^2_m is the maternal genetic variance, σ_{am} is the additive direct and maternal genetic covariance, σ^2_{pe} is the maternal permanent environmental variance, and I_d, I_N are identity matrices of appropriate order, the number of dam and number of animals with records respectively.

Estimates of additive direct (h^2_a) and maternal (h^2_m) heritabilities were calculated as ratios of estimates of additive direct (σ^2_a) and maternal genetic (σ^2_m) variances, respectively to the phenotypic variance (σ^2_{ph}). The direct maternal correlation (r_{am}) was computed as the ratio of the estimates of direct maternal covariances (σ_{am}) to the product of the square roots of estimates of σ^2_a and σ^2_m. σ^2_{pe} is the ratio of estimates of maternal environmental variance (σ^2_{pe}) to the total phenotypic variance (σ^2_{ph})

RESULTS AND DISCUSSION

Overall Means

Unadjusted means and their standard errors (SE) and coefficients of variability (CV) for birth weight (BW), weaning weight (WW) and daily gain (DG) from birth to weaning are presented in Table 1.

Table (1) Unadjusted means for birth weight (BW), weaning weight (WW) and daily gain (DG) from birth to weaning.

Trait	Mean	SD	CV%
BW, kg	30.8	5.1	16.5
WW, kg	96.5	10.2	10.6
DG, g/day	547	89	16.4
No. of records	1713		

Genetic parameters

Estimates of variance and covariance components are shown in Table 2 while in the Table 3 are those for other genetic parameters. Comparable recent estimates on Hereford cattle are 0.41 and 0.24 for direct heritability of BW and WW respectively (Meyer, 1992). The present estimates indicate the direct heritability (h^2_a) of BW and WW are approximately 2.5 times their respective maternal part while the direct heritability, DG was approximately four times that of the maternal part. Khombe *et al.*, (1995) working on Mashona cattle, found that direct heritability at weaning was estimated higher than maternal heritability. Estimates of maternal heritabilities for BW, WW and DG were 0.17, 0.14 and 0.09, respectively. The present estimates of maternal heritability suggest that maternal effects need to be considered in the analysis model and the selection for growth traits in Friesian calves in Egypt. The present results agree with those obtained by Bennett and Gregory (1996), who estimated heritability of direct genetic effects for birth weight and 200d weight, as 0.50 and 0.32 and heritability for maternal effects as 0.09 and 0.10 for the same traits, respectively.

Table (2) Estimates of direct and maternal genetic variance and covariance components, permanent environmental and residual of different growth traits.

Item	Direct and maternal genetic variances and covariances					
1- Genetic effects	BW_a	WW_a	DG_a	BW_m	WW_m	DG_m
BW, direct (BW_a)	**12.956**					
WW, direct (WW_a)	11.355	**41.610**				
DG, direct (DG_a)	-20.369	227.419	**1749.057**			
BW, maternal (BW_m)	-1.928	-10.028	-35.327	**6.851**		
WW, maternal (WW_m)	-4.938	-7.675	-23.366	6.109	**17.554**	
DG, maternal (DG_m)	-38.940	-8.348	-16.993	-0.699	9.406	**421.939**
2- Non genetic effects						
a- Permanent environmental						
	BW		WW		DG	
BW	**5.105**					
WW	-6.025		**9.389**			
DG	15.855		-1.280		**182.630**	
b- Residual						
BW	**16.159**					
WW	12.966		**53.151**			
DG	-14.111		330.660		**2311.755**	
c- Phenotypic*						
BW	**41.071**					
WW	39.929 (0.56)		**121.704**			
DG	-96.733 (-0.22)		699.660 (0.93)		**4665.381**	

* Phenotypic correlations between parenthesis.
** Variances on the diagonal and covariances below the diagonal.

Similarly, Tosh *et al.*, (1999) working on a multibreed population of beef cattle, found that the direct heritability of 0.51 and 0.33 for birth weight and weaning weight larger than maternal heritabilities of 0.09 and 0.13 for birth and weaning weights, respectively.

Direct genetic correlation between BW and WW is moderate (0.49) and that between BW and DG was small and negative (-0.14), while the direct correlation between WW and DG was positive and high (0.84). Likewise, phenotypic correlations between these traits had also the same trend. The correlation between direct genetic effects for birth and weaning weights indicating a positive relationship between pre- and postnatal direct genetic effects. These results are similar to those summarized by Koots *et al.*, (1994b).

The estimates of correlations between direct and maternal genetic effects were negative for all traits studied. The negative correlations between direct and maternal genetic effects suggest that many of genes which favour the milking and mothering ability of a cow are partly detrimental for growth of the young calf (Mohiuddin, 1993). Negative genetic correlations between direct and maternal for birth weight and/or weaning weight have been reported by Tawah *et al.* (1993); Varona *et al.* (1999) and Lee *et al.* (2000) and ranged from -0.30 to -0.91. Lee *et al.* (2000) reported a negative estimates (-0.91) of direct-maternal genetic correlation for weaning weight that was inflated when the effects of sir x year interaction was not included in the model. In addition, Koch *et al.*, (1972) suggested that the negative correlations between direct and maternal genetic effects could be due to a negative direct influence of the dams on the maternal ability of their female offspring through overfeeding. These negative correlations may be the result of an adaptation of the animals to the dry tropical environment where food resources are scare (Tawah *et al.*, 1993).

Table(3):Direct and maternal heritabilities (diagonal), direct and maternal genetic correlations and direct maternal genetic correlations (below the diagonal) between different traits investigated.

Item	BW_a	WW_a	DG_a	BW_m	WW_m	DG_m
BW, direct (BW_a)	0.32					
WW, direct (WW_a)	0.49	0.34				
DG, direct (DG_a)	-0.14	0.84	0.37			
BW, maternal (BW_m)	-0.20	-0.59	-0.32	0.17		
WW, maternal (WW_m)	-0.33	-0.28	-0.13	0.56	0.14	
DG, maternal (DG_m)	-0.53	-0.06	-0.02	-0.01	0.11	0.09

In present study, the maternal permanent environmental effect on BW, WW and DG due to dams accounted for 12%, 8% and 4%, respectively from the phenotypic variance. Koch *et al.*, (1994) estimated permanent environmental effect on WW was 5% from phenotypic variance, compared to 8% as reported by MacNeil *et al.*, (1998).

The present study showed that the genetic correlation between BW and WW was smaller than 0.50 and that between BW with DG negative, suggesting that postnatal growth can be increased without increasing birth weight. It could be concluded that selection for WW and growth rate based on direct genetic components only may not give optimal response because of the negative genetic correlation between direct and maternal effects. Therefore, future selection plans for growth traits need to consider maternal effects in the analysis models in order to optimize expected total response over the long run.

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المكونات الوراثية الأمية وعلاقتها بالمكونات الوراثية المباشرة لبعض صفات النمو فى عجول الفريزيان فى مصر

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استخدم فى هذه الدراسة ١٧١٣ سجلا لصفات النمو من الولادة حتى الفطام لعجول الفريزيان (٨١٣ ذكر و ٩٠٠ أنثى) نسل ٧٠٣ بقرة و ٩٣ أب خلال الفترة ١٩٨٢ حتى ٢٠٠١ بمزرعة سخا والقرضا. قدرت مكونات التباين باستخدام طريقة الاحتمالات العظمى المحددة Restricted Maximum Likelihood لنموذج الحيوان والمشتمل على العوامل الثابتة كسنة وشهر الميلاد والجنس والمزرعة والموسم (عدد الولادات). أما العوامل العشوائية فاشتملت على الحيوان، التأثير الوراثى المباشر والتأثير الوراثى الأمى للحيوان، التأثير الأمى البيئى الدائم والتأثير المتبقى. بينما أخذ وزن الأم عند الولادة كانحدار. كما قدرت التأثيرات الوراثية المباشرة والأمية والمعايير الوراثية الأخرى للوزن عند الميلاد ، الوزن عند الفطام ومعدل النمو اليومى من الميلاد حتى الفطام.

كانت المتوسطات العامة والانحرافات القياسية للوزن عند الميلاد ، الوزن عند الفطام ومعدل النمو اليومى من الميلاد حتى الفطام ٣٠,٨ ±٥,١ كجم ، ٩٦,٥±١٠,٢ كجم و ٥٤٧±٨٩ جم/ يوم على التوالى.

قدرت المكافئات الوراثية للتأثير الوراثى المباشر للصفات السابقة بـ ٠,٣٢ ، ٠,٣٤ و ٠,٣٧ على التوالى. كانت تقديرات المكافئات الوراثية للتأثير الوراثى الأمى أصغر من المكافئات الوراثية للتأثير الوراثى المباشر ٠,١٧ ، ٠,١٤ و ٠,٠٩ لنفس الصفات السابقة على التوالى.

كانت تقديرات التباين الأمى البيئى الدائم كنسبة من التباين الكلى ٠,١٢، ٠,٠٨ و ٠,٠٤ للوزن عند الميلاد ، الوزن عند الفطام ومعدل النمو اليومى من الميلاد حتى الفطام على التوالى.

كانت جميع الارتباطات بين التأثيرات الوراثية المباشرة والأمية سالبة بين الصفات المدروسة وتراوحت من -٠,٥٩ إلى -٠,٠٢.

كان الارتباط الوراثى والمظهرى بين الوزن عند الميلاد ومعدل النمو اليومى كان صغيرا وسالبا ٠,١٤-، و-٠,٢٢ على التوالى بينما كان الارتباط الوراثى والمظهرى بين الوزن عند الفطام ومعدل النمو اليومى مرتفعا وموجبا ٠,٨٤، و ٠,٩٣ على التوالى.