ADDITIVE AND HETEROZYGOTIC EFFECTS ON BODY WEIGHT TRAITS OF CHAROLAIS, CARACU AND CHAROLAIS x CARACU CROSSES IN PARANÁ-BRAZIL

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SUMMARY

Records of 606 animals from a crossbreeding experiment between Charolais (Ch) and Caracu (Ca), carried out at Estação Experimental Fazenda Modelo, in Ponta Grossa-PR, Brazil, from 1981 to 1992, were analyzed to estimate additive and heterozygotic effects on birth weight (BW), weaning weight (WW), daily gain from birth to weaning (DGBW), yearling weight (YW) and daily gain from weaning to yearling (DGWY). Data were analyzed by least squares, fixed-effects procedures, fitting a breed group model (BGM) and a multiple regression model (MRM). The BGM yielded significant ($P<0.05$) estimates of F1 heterosis for BW (2.3±1 kg), YW (11.9±6 kg) and DGWY (87±36 g/d). Backcross heterosis was significant ($P<0.01$) for BW, (3.7±1 kg), YW (15.0±5 kg) and DGWY (83±30 g/d). Heterosis retained by the rotational crossbreeding system was 3.1±1 kg ($P<0.01$) for BW, 12.8±6 kg ($P<0.05$) for YW and 93±35 g/d ($P<0.01$) for DGWY. No heterosis was found for WW nor for DGBW. From the MRM, the direct effect of the Ch was positive ($P<0.001$) for BW (3.5±1 kg), but negative ($P<0.01$) for WW (-13.1±5 kg) and for DGBW (-65±21 g/d). The Ch maternal effect was negative ($P<0.01$) for both WW (-11.7±4 kg) and DGBW (-49±18 g/d). Individual heterozygosity effects were 1.2±1 kg and 6.1±3 kg ($P<0.05$) for BW and for YW, respectively, and 48±17 g/d ($P<0.01$) for DGWY. Maternal heterozygosity effects were significant ($P<0.01$) for BW (1.3±1 kg) only.

INTRODUCTION

Reports on crossbreeding research for beef in tropical and semi-tropical zones are scarce. This experiment was undertaken to evaluate the merits of rotational crossbreeding between Charolais (Ch) and Caracu (Ca), a Criollo breed, for beef production in a sub-tropical region of Paraná-Brazil.

MATERIALS AND METHODS

The experiment was conducted at Estação Experimental Fazenda Modelo, in Ponta Grossa, Paraná, Brazil. The site is located 783m above sea level, at 50°9' West and 25°6' South. The averages of annual rain fall and temperature are 1402mm and 18°C, respectively.

The mating plan generated straightbred Ch and Ca and three crossbred generations from a rotational crossbreeding scheme between these breeds. The crossing system was initiated by reciprocal matings and continued by mating Ch and Ca bulls to the successive generations of crossbred cows. Numbers of cows/mating type/year were 25. Natural services were used with a bull:cow rate of 1:17. Bulls that sired the straightbreds also sired the crossbreds. Cows were maintained on native pastures (*Traquipogon spp*, *Andropogon spp*, *Paspalum plicatulum* and *Paspalum guenarum*) and supplemented during the winter by grazing on oat and rye grass pastures. After weaning, calves were maintained on cultivated pastures of *Paspalum notatum* cv. IPEAME and *Hemarthria altissima*. Numbers of animals by breed group that supplied data for the study are shown in table 1.

Birth weight (BW), taken within the first 24 hours after birth, weaning weight (WW), taken at an average age of 206 days, daily gain from birth to weaning (DGBW), yearling weight (YW), taken at an average age of 372 days, and daily gain from weaning to yearling (DGWY) of 606 animals born from 1981 to 1992 were the traits studied. Numbers of records per trait are shown in table 2.

Two alternative fixed-effects models were fitted to the data of each trait by least squares methods. A breed group model (BGM) included the effects of breed group (8 levels), sex (2 levels), year of birth (12 levels) and month of birth (10 levels). In a multiple regression model (MGM), the breed group was replaced with multiple regression coefficients to estimate the contributions of breed direct, breed maternal, individual heterozygosity (ChCaI) and maternal heterozygosity (ChCaM) effects to differences in the traits. The expected fractions of the genetic effects fitted in the MRM are shown in table 1 for the eight breed groups. The Ca direct (CaI) and Ca maternal (CaM) effects were set to zero so that the Charolais direct (ChI) and the Charolais maternal (ChM) effects were estimated as deviations from the corresponding Ca values. In both models, BW and age at weaning were included as covariates for WW and for DGBW. WW and age at yearling were used as covariates for YW and for DGWY.

Table 1. Numbers of animals by breed group and expected fractions of genetic effects according to breed group

Breed group	Number of animals	Genetic effect[1]					
		ChI	CaI	ChM	CaM	ChCaI	ChCaM
Ch	193	1	0	1	0	0	0
1Ch1Ca	67	1/2	1/2	0	1	1	0
1Ca1Ch	92	1/2	1/2	1	0	1	0
Ca	107	0	1	0	1	0	0
3Ch1Ca	85	3/4	1/4	1/2	1/2	1/2	1
3Ca1Ch	74	1/4	3/4	1/2	1/2	1/2	1
5Ch3Ca	12	5/8	3/8	1/4	3/4	3/4	1/2
5Ca3Ch	22	3/8	5/8	3/4	1/4	3/4	1/2

[1]ChI, ChM, CaI and CaM are the additive effects of Ch and Ca for individual (I) and for maternal (M) performance, respectively. ChCaI and ChCaM are the individual (I) and maternal (M) heterozygosity effects, respectively.

RESULTS

Probability levels for the F values from both models and for all traits were highly significant (P<0.001). R-Square values indicated the equivalence of the models. Other results are given in table 2.

The breed group means for the various traits are compatible with the experimental environment. F1 heterosis (F1H), [(1Ch1Ca+1Ca1Ch)/2-(Ch+Ca)/2], was significant (P<0.05) for BW (2.3±1 kg), YW (11.9±6 kg) and DGWY (87±36 g/d). No F1H was found for WW nor for DGBW. Backcross heterosis (BCH), [(3Ch1Ca+3Ca1Ch)/2 - (Ch+Ca)/2], was highly significant (P<0.01) for BW (3.7±1 kg), YW (15.0±5 kg) and DGWY (83±30 g/d). Heterosis retained by the rotational crossbreeding system (RCH), [(3Ch1Ca + 3Ca1Ch + 5Ch3Ca + 5Ca3Ch)/4] - (Ch+CA)/2], was 10%, 6.4% and 47% above mid-parent values for BW, YW and DGWY, respectively.

The MRM showed that ChI effects were positive (P<0.001) for BW (3.5±1 kg), but negative (P<0.01) for both WW (13.1±5 kg) and DGBW (65±21 g/d). ChM effects were negative (P<0.01) for both WW (11.7±4 kg) and DGBW (49±18 g/d). For each tenth of increase in individual heterozygosity (ChCaI), BW, YW and DGWY would increase by 0.12 kg, 0.61 kg and 4.8 g/d, respectively. Maternal heterozygosity effects (b_{ChCaM}) were significant (P<0.01) for BW only.

DISCUSSION

Lack of heterosis for WW and for DGBW was determined mostly by the performances of the 1Ca1Ch, which differ (P<0.05) from those of 1Ch1Ca, but were similar (P>0.05) to those of Ch. Milk production of Ch mothers, which is low (Cundiff et al., 1988), was certainly worsened by the nutritional environment of the experiment and may have set a limit to pre-weaning gains of both Ch and 1Ca1Ch calves.

The differences between Ch and Ca for WW and for DGBW confirm the Ca superiority for performance in unfavourable environment (Wilkins, 1993; Lemos da Silva et al. 1993).

Being equivalent to the BGM, the MRM has the advantage of allowing for the prediction of crosses of interest. As an example, the derived predictive equation for YW would be: YW = Ca (LS Mean) - 3.1(ChI) - 2.5(ChM) + 6.1(ChCaI) + 4.5(ChCaM).

Overall, the results show that the rotational crossbreeding system can retain a considerable amount of heterosis for post-weaning gain up to yearling age.

Table 2. Numbers of observations (Obs.) least squares means according to breed group, estimates of heterosis (from BGM) and estimates of genetic effects (from MRM) on body weight traits of Charolais, Caracu and Charolais x Caracu crosses

Item[1,2]	Trait[3]				
	BW	WW	DGBW	YW	DGWY
Obs.	604	533	528	508	505
Ch	33±0.66	135±3.8	504±17.1	196±3.9	179±23.5
Ca	29±0.76	160±4.2	618±19.0	203±4.2	215±25.4
1Ch1Ca	32±0.81	152±4.7	585±20.9	206±4.7	244±28.5
1Ca1Ch	33±0.79	141±4.5	539±20.1	205±4.4	238±27.0
3Ch1Ca	34±0.80	148±4.5	565±20.0	208±4.5	245±27.2
3Ca1Ch	32±0.81	154±4.5	601±20.1	206±4.4	232±26.7
5Ch3Ca	31±1.46	153±8.4	597±37.3	204±7.7	253±46.4
5Ca3Ch	33±1.19	147±6.7	562±30.1	205±6.3	246±38.0
F1H	2.3^{*}±1	-1.2±7	2±30	11.9^{*}±6	87^{*}±36
BCH	3.7^{***}±1	7.5±5	43±24	15.0^{**}±5	83^{**}±30
RCH	3.1^{**}±1	6.1±6	40±28	12.8^{*}±6	93^{**}±35
$b1_{ChI}$	3.5^{***}±1	-13.1^{**}±5	-65^{**}±21	-3.1±4	-13±25
$b2_{ChM}$	1.0±1	-11.7^{**}±4	-49^{**}±18	-2.5±4	-15±30
$b3_{ChCaI}$	1.2^{*}±1	-0.5±3	2±14	6.1^{*}±3	48^{**}±17
$b4_{ChCaM}$	1.3^{**}±1	4.1±3	21±13	4.5±3	18±16

[1]Breed groups and genetic effects are defined in the text. [2]b1, b2, b3 and b4 are partial regression coefficients of phenotypes on the expected fractions of the corresponding genetics effects. [3]BW, WW and YW are expressed in kg. DGBW and DGWY are expressed in g/d. *P<0.05, **P<0.01 and ***P<0.001.

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