Performance of taurine x Gudali zebu crosses subjected to artificial suckling in the tropical highlands of Cameroon

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Key words

Holstein cattle - Montbeliard cattle - Gudali zebu - Crossbreeding - Weaning weight - Growth - Genotype - Cameroon.

Summary

Calf genotype, sex of calf, year of birth, cow age at birth of calf, calf weaning age and calf birth date were analyzed to determine their effects on birth weight, pre-weaning average daily gain, weaning weight and adjusted weaning weight. These data were generated from three-quarter-bred Montbeliard (M3G1) and three-quarter-bred Holstein (H3G1) calves in the tropical highlands of Cameroon. Effects of calf genotype, year of birth and cow age at weaning significantly influenced growth and weaning weight traits. H3G1 calves were 10% significantly heavier than M3G1 calves at weaning. As expected, males tended to be heavier at birth and weaning than their female contemporaries. However, these differences were not statistically significant. This study further suggests that genetic (genotype) research needs to be carried out in combination with management (age of cow and year of calf birth) in order to optimize growth in dairy crosses in this environment.

■ INTRODUCTION

Crossbreeding has been identified as one of the main strategies for the genetic improvement of indigenous cattle for milk production in the tropics (2, 8, 13, 20, 33, 38). Additionally, similar studies have found it to be important to obtain rapid beef production under tropical conditions (16, 17, 37). However, crossing indigenous zebu cattle and exotic dairy cattle generally produces a dual-purpose (milk and meat) genotype. Dual-purpose cows, under the circumstance, are expected to produce milk and meat for the resource-poor people. Recent studies (3, 4, 15) under various pasture scenarios in the subtropics have shown marked differences in milk and meat production in the dual-purpose animals. Besides, pasture grasses in the tropics tend to mature rapidly and thus have considerable influence on animal performance as demonstrated by Ndikum-Moffor *et al.* (27) and other authors, who have indicated deficiencies in protein, calcium and phosphorus. These nutrients are important for growth, reproduction and milk production.

Additionally, effects of cow age, management, size, milk yield, breeding and maternal ability of the dam as well as sex, age at weaning, management and breeding of the progeny on pre-weaning growth of beef calves have been extensively studied (16, 32, 34, 35). Based on these results it was established that at least 50% of the variation in pre-weaning growth of the calf is due to the milk yield of its dam (3, 7, 32, 41), which explains the use of dairy breeds in crossbreeding with beef breeds (37). Such dairy-beef crosses are expected to produce more milk and, hence, wean heavier calves relatively to their "traditional" beef contemporaries.

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As already indicated, crossbreeding with beef and dairy breeds usually results in dual-purpose genotypes. Mbah *et al.* (24) as well as most of the authors in the literature focused mainly on their dairy performance. Information on their growth potential is therefore lacking. The pre-weaning growth of these dual-purpose genotypes cannot be ignored because, besides being correlated with post-weaning growth (10, 28, 42), it plays an important role in their milk production. Christain *et al.* have reported a negative correlation between weaning weight and measures of milk production (10). This pattern could be interpreted as a negative genetic or an environmental correlation, or both, between the weaning performance of the dam and the maternal environment she provides for her calf. If this correlation is genetic, then heifers selected for their higher weaning weight will be expected to produce genotypes with increased growth and decreased milk production potentials. Hence, the objective of this study was to investigate the effects of genetic and non-genetic factors on the pre-weaning growth of dairy taurine x (Gudali) zebu crosses in the tropical highlands of Cameroon.

■ MATERIALS AND METHODS

Description of the study environment

The study was conducted in the Dairy Research Unit of the Animal Research Station at Wakwa on the Adamawa highlands. The highlands cover an area of about 72,000 km². Although they extend from Nigeria to Cameroon, the Adamawa plateaux are mostly located in Cameroon between latitudes 6-8°N and longitudes 10-16°E. The climate is mild and semi-temperate because of the altitude. These conditions favor the promotion of intensive beef and dairy cattle production on the plateau. Indeed, Adamawa is the major cattle-rearing zone in Cameroon, carrying the largest population of cattle in the country.

Wakwa is at an altitude averaging approximately 1200 m above sea level and endowed with a mild climate (22°C mean annual temperature, 1600 mm mean annual rainfall spread between April and October and 40-60% mean relative humidity). Pamo and Yonkeu (30) and Mbah *et al.* (24) have documented the climatic conditions in Wakwa. Wakwa station is located in the sub-humid zone, which is characterized by a sudano-guinean climate. The vegetation, which is predominantly woody savannah, has been described by Piot and Rippstein (31). The major pathological problems include ticks, tick-borne diseases and dermatophilosis (21, 22). The vectors responsible for transmitting trypanosomosis (*Glossina*) were eradicated in Wakwa in the late ’80s (24). Crossbred genotypes have been shown to be highly susceptible to most of these diseases (21, 22) and heat stress (23).

Experimental animals and management

Data for this investigation were collected from three-quarter-bred Montbeliard (M3G1) and three-quarter-bred Holstein (H3G1) calves at the Animal and Veterinary Research Station of Wakwa between 1982 and 1988. These animals were born from Montbeliard x Gudali and Holstein x Gudali F1 cows by artificial insemination (AI) with imported Montbeliard and Holstein semen, respectively. The F1 cows were obtained through AI of Gudali cows using similarly imported semen. The backcrosses were the only genotypes with sufficient numbers of records to allow for sound statistical analysis and comparisons.

The dams were allowed to suckle their calves for about 24 h after birth. This was to ensure that the calves had a good intake of colostrum, which is not only necessary for protection (absorption of antibodies) of the animals during the early stages of life, but also to promote their growth and development, as colostrum has been shown (18) to be richer in energy, vitamins and trace minerals than ordinary cow milk. Calves were normally closely monitored by the herdsmen to make certain that their dams suckled them. Calves, which for one reason or another were abandoned by their dams, were provided colostrum collected from their mothers within the first 24 h after birth. The provision of colostrum to ensure the absorption of antibodies is particularly most efficient during the first 24 h after birth (18). They were ear-tagged and weighed within 24 h of birth.

The calves were then taken away from their mothers and kept in individual pens in the calf barn. They were intensively maintained in the barn for a period of about three months. This is an earlier weaning scheme when compared with the extensively managed beef calves on the station, which run with their dams until weaned at about eight months. During this period, the calves were allowed to suckle from artificial teats (or bucket-feeding) varying amounts of pooled milk from twice daily milking on the basis of 10% of their body weight. Forages (succulent *Brachiaria ruziziensis* mostly), grass and legume hay were introduced *ad libitum* from week 3 as well as a 20% crude protein calf concentrate. The milk offered was correspondingly reduced until the calves were weaned at about three months of age. The calves were regularly weighed every month up to weaning and thereafter. Once weaned, both male and female calves were transferred to their respective weaner herds in the Beef Research Unit.

Calves were offered water freely. Calf bedding was straw during the dry season (winter) and wood shavings during the wet season (summer). Bedding was routinely changed to minimize the danger of calf-hood infections. Basic prophylactic measures (immunization, deworming and tick control) against major calf diseases such as contagious bovine pleuropneumonia and hemorrhagic septicemia were routinely effected. Regular treatment of sick animals was also carried out.

Statistical analysis

The traits analyzed were birth weight (BWT), weaning weight (WWT), pre-weaning average daily gain (ADG = (WWT-BWT) /age in days) and adjusted weaning weight (AWWT = BWT + (ADG x 90)). The data were checked for consistency and analyzed by fitting the following fixed-effects linear statistical model:

$$Y_{ijkl} = \mu + \alpha_i + \delta_j + \beta_k + b(X_{ijk}-) + e_{ijkl}$$

where Y_{ijkl} is the performance record (BWT, WWT, ADG and AWWT) for the lth animal;

μ is the overall mean;

α_i is the effect due to calf breeding (i = M3G1 and H3G1);

δ_j is the effect due to sex of calf (j = male and female);

β_k is the effect due to year of calving (k = 1982-1988);

$b(X_{ijk}-)$ is the regression of performance record on age of cow at calving, where b is the regression coefficient and $(X_{ijk}-)$ is covariate (age of cow at calving) as a deviation from its mean, and e_{ijkl} is the residual effect, which is assumed to be an independently and identically normally distributed random effect with a mean of zero and a variance of σ^2.

This analysis was carried out using the least squares analysis of variance procedures of SPSS (29) on a PC computer. Also included in this model were age of calf at weaning and date of birth of calf, which were found to be statistically insignificant. As a result they were dropped out of the final model.

■ RESULTS

Least squares analysis of variance (table I) showed that the calf genotype (P < 0.05), year of birth (P < 0.01) and cow age at calving (P < 0.01 or P < 0.05) affected pre-weaning average daily gain and weaning weight. It was also evident from these results that the calf genotype (P < 0.05) and year of birth (P < 0.01) also significantly influenced the adjusted weaning weight. The year of birth (P > 0.09) and sex of calf (P > 0.06) only showed a tendency to significantly affect the birth weight.

The age of cow at calving showed a significant linear relationship with the pre-weaning average daily gain and weaning weight despite the fact that these calves were separated from their dams 24 h after birth and that the calf birth date showed no significant relationship with the birth weight. The age of cow, however, had no significant association with the adjusted weaning weight. As expected, the age at weaning had an insignificant influence on the weaning weight since these calves were not allowed to run with their dams on the pastures as was the practice with beef cattle herds. Even though the year of birth significantly influenced most of these traits, there was only an apparent evidence of a decreasing trend from 1982 to 1988. This trend may have been due to the size selection used (ease of calving was a major criterion in the choice of semen for artificial insemination), and hence the production of smaller calves, rather than to the small number of animals in the earlier years of the study. It is, however, also possible that husbandry, climatic and nutritional conditions may have changed during the course of the study, and such changes could have indirectly affected the growth of the animals. This is obvious from the pattern of growth registered from 1982 to 1985 and from 1986 to 1988.

Least squares means (table I) indicate that males were as expected 7.2 and 5.1% heavier than their female contemporaries at birth and weaning, respectively. The differences were, however, not statistically significant. From the least squares means of calf genotypes presented in table I, three-quarter-bred Holsteins were 4.1% heavier (P > 0.05) at birth, had an 18.4% higher (P < 0.05) rate of growth from birth to weaning and attained an 11.0 and 11.1% higher (P < 0.05) weaning weight and adjusted weaning weight, respectively, than calves with three-quarter Montbeliard breeding.

■ DISCUSSION

The high rate of pre-weaning losses (57.8%) in the dairy unit suggests that the 24-hour allowance for calves to absorb antibodies from the colostrum from their dams might have been inadequate. Libersa *et al.* (18) suggest that these calves should normally be allowed at least 48 h of suckling by their dams, as the colostrum they receive from their mothers is not only richer in antibodies than ordinary cow milk but also in energy, vitamins and trace minerals, which are necessary for the growth and development of the young growing animal. This practice is especially recommended for dairy calves in the tropics, where the environment is usually laden with parasites as well as heat and humidity. Scouring was also a major cause of calf deaths in the dairy unit, probably associated with the preparation of milk for feeding these young animals. As already indicated most of these calves may also have been born with extremely small birth weights as there was a deliberate selection for small birth weight. This might also have had an effect on the pre-weaning losses.

Table I

Least squares means of pre-weaning growth traits of crossbred dairy cattle

Source of variation	N (at birth)	BWT (kg)	N (at weaning)	ADG (kg/d)	WWT (kg)	AWWT (kg)
Overall mean	90	35.0	52	0.42	72.5	72.0
Calf breed		ns		*	*	*
M3G1	51	34.4	29	0.39	69.4	68.5
H3G1	39	35.8	23	0.46	76.4	76.4
Calf sex		ns		ns	ns	ns
Male	48	36.1	26	0.42	74.3	73.1
Female	42	33.7	26	0.42	70.7	70.9
Year		ns		**	**	**
1982	11	33.0	9	0.57	81.6	83.9
1983	11	39.3	3	0.48	83.5	80.6
1985	14	35.0	10	0.47	77.2	77.0
1986	16	36.4	9	0.36	73.7	68.5
1987	16	34.5	8	0.38	68.6	67.4
1988	22	33.1	13	0.33	61.5	63.2
Cow age		ns		**	*	*

N = number of observations; BWT = birth weight; ADG = average daily gain from birth to weaning; WWT = weaning weight; AWWT = adjusted weaning weight
ns = not significant; * P < 0.05; ** P < 0.01

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Surprisingly, the year of birth in the present study only showed a tendency to influence the birth weight. This is contrary to the findings of Mbap and Ngere (25) who reported significant effects of the year and season of birth on the birth weight of Friesian cattle in neighboring Nigeria. Heat stress during gestation has been shown to reduce the birth weight in rats (5), sheep (6, 9) and cattle (11). Additionally, the dry season on the Adamawa plateau has been shown to substantially affect the cow body weight, with a recorded loss of about 20% (14). Since the cow weight is positively correlated with the calf birth weight, a loss in the cow weight is expected to contribute to reduced birth weight in calves. The early maturity of fodder grasses and the fact that these grasses are generally deficient in essential nutrients such as proteins and minerals (27) aggravate this effect. Although the effect of the season on the birth weight in the present study was confounded with that of the year of birth, it is not expected to be of any significance as pregnant dairy cows were managed somewhat intensively throughout the year. They were usually provided with supplements throughout the duration of pregnancy. This practice may somewhat account for the lack of effect of the year of birth on the birth weight.

The birth weight is related to pre-weaning growth (ADG) and the weaning weight (10, 28, 42). Therefore, a reduction in the birth weight is expected to contribute to a decrease in growth from birth to weaning and a reduction in the weaning weight. That there was no significant relationship between the age at weaning and the weaning weight in the present study may be because only bulls with a high score for calving ease were retained in the breeding program. Moreover, as previously observed, these calves were not subjected to weaning stress because they were usually raised away from their dams, i.e., they were subjected to artificial suckling in individual calf pens under specially designed housing conditions.

The surprising lack of significant sexual differences between these traits may be an indication that feeding was not adequate enough to elicit the expression of sexual dimorphism in these genotypes. Thorpe *et al.* (40) and Lubout (19) made a similar observation. Tawah *et al.* (39) have also reported a non-significant effect of sex on birth weight of Gudali calves. These results were contrary to expectations, i.e., males are usually heavier than females at all ages of the growth curve (1, 16, 36). Equally surprising was the fact that the cow age and calf growth from birth to weaning were significantly positively related, which may be an indication that prenatal maternal effects were carried over by the progeny to the period after birth, particularly as these calves were similarly managed. It is also possible that rapidly growing calves which tended to consume more milk than the slow growers may have come from higher yielding cows by chance.

Breed differences in respect of growth are an important factor for the genetic improvement of the efficiency of beef and dairy production. Three-quarter-bred Holstein crosses were heavier at weaning and gained weight faster than three-quarter-bred Montbeliard genotypes in the present study. This was as expected under similarly improved management. These results suggest that breed differences in respect of growth from birth to weaning and weaning weight of progeny are strongly associated with the genetic potential for growth. The Holstein breed has definitely a better potential for a more rapid growth up to weaning than the Montbeliard under similar production conditions. This is additional evidence that crossing Holsteins with zebu cattle breeds should provide the calves with a pre-weaning growth advantage (12). This is because Holstein crosses are much better dairy genotypes than Montbeliard crosses under improved management

conditions in the tropics (37). It is obvious, despite the production advantage of the Holstein crosses, that the economies of scale will help target the correct genotype to use under various production scenarios in the tropics.

■ CONCLUSION

The three-quarter-bred Holstein calves showed better growth potential from birth to weaning than those with three-quarter Montbeliard breeding. Both genetic (genotype) and non-genetic factors (cow age at birth of calf, year of birth) affected the pre-weaning growth of these calves substantially. While the appropriate genotype can be selected from a larger sample of calf genotypes, the non-genetic factors could partly be controlled by improved management. Both conditions are necessary and sufficient pre-requisites to improve production in the tropics.

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Résumé

Tawah C.L., Mbah D.A., Enoh M.B., Messine O. Performances de veaux croisés taurins x zébus Gudali allaités artificiellement dans la zone tropicale montagneuse du Cameroun

Les effets du génotype et du sexe du veau, de l'année de naissance, de l'âge de la vache au vêlage, de l'âge du veau au sevrage et de la date de naissance du veau sur le poids à la naissance, le gain moyen quotidien avant sevrage, le poids au sevrage et le poids au sevrage ajusté ont été étudiés. Ces données ont été obtenues à partir de veaux aux trois-quarts-de-sang Montbéliard (M3G1) et aux trois-quarts-de-sang Holstein (H3G1) dans la zone tropicale montagneuse du Cameroun. Les effets du génotype du veau, de l'année de naissance et de l'âge de la vache au sevrage ont eu une influence significative sur les caractères de croissance et le poids au sevrage. Les veaux H3G1 ont été significativement plus lourds de 10% que les veaux M3G1 au sevrage. Comme prévu, les veaux mâles avaient tendance à être plus lourds à la naissance et au sevrage que les femelles du même âge. Toutefois, ces différences n'étaient pas statistiquement significatives. Par ailleurs, cette étude suggère que la génétique (génotype) et la gestion (âge de la mère et année de naissance du veau) devraient être prises en compte conjointement afin d'optimiser la croissance des bovins laitiers issus de croisements dans cet environnement.

Mots-clés : Bovin Holstein - Bovin Montbéliard - Zébu Gudali - Croisement - Poids au sevrage - Croissance - Génotype - Cameroun.

Resumen

Tawah C.L., Mbah D.A., Enoh M.B., Messine O. Rendimiento de cruces taurinos x cebú Gudali, sometidos a mamaderas artificiales en las tierras altas tropicales de Camerún

Se analizaron genotipo del ternero, sexo del ternero, año de nacimiento, edad de la vaca al parto del ternero, edad de destete y fecha de parto del ternero, con el fin de determinar el efecto de éstos sobre el peso al nacimiento, la ganancia promedio diaria pre destete, el peso al destete y el peso al destete ajustado. Estos datos fueron generados a partir de terneros tres cuartos raza Monbeliard (M3G1) y Holstein (H3G1), en las tierras altas tropicales de Camerún. El efecto del genotipo del ternero, del año de nacimiento y de la edad de la vaca influenciaron significativamente los rasgos de crecimiento y destete. Los terneros tres cuartos de raza Holstein fueron, significativamente, 10% más pesados que los terneros M3G1 al destete. Como era de esperar, los machos fueron más pesados al nacimiento y al destete que las hembras. Sin embargo, estas diferencias no fueron estadísticamente significativas. El presente estudio sugiere que la investigación genética (genotipo) debe ser llevada a cabo en combinación con el manejo (edad de la vaca y año de nacimiento), con el fin de optimizar el crecimiento en cruces lecheros en este medio.

Palabras clave: Ganado bovino Holstein - Bovino ganado Montbeliard - Cebú Gudali - Cruzamiento - Peso al destete - Crecimiento - Genotipo - Camerún.

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