Factors Affecting Growth Performance in Purebred Gudali and Two-Breed Synthetic Wakwa Beef Cattle in a Tropical Environment

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Key words

Gudali cattle – Wakwa cattle – Animal performance – Growth factor – Cameroon.

Summary

Data were collected on preweaning and postweaning growth performance of calves from purebred Gudali and two-breed synthetic Wakwa beef cattle, at the Agricultural Research Centre, Wakwa, Ngaoundere, Cameroon. Data were analyzed using a mixed model procedure to determine factors affecting the performance. Results showed that maternal, sex, herd, calving season and year, age at weaning (WAGE), exact age (days) at weighing for yearlings (YAGE) and eighteen-month-old calves (EAGE) effects significantly ($P < 0.01$ or $P < 0.001$) affected preweaning and/or postweaning performances. Male calves performed better than female calves in Gudali and Wakwa breeds by 0.8 and 0.6 kg for the birth weight (BWT), 11.3 and 12.8 kg for the preweaning weight (WWT), 14.5 and 15.1 kg for the yearling weight (YWT), 13.4 and 11.9 kg for the eighteen-month weight (EWT), and for preweaning growth by 0.04 and 0.06 kg/day, respectively. Calves born in the dry season were heavier than those born in the rainy season in Gudali and Wakwa breeds by 19.0 and 21.7 kg (WWT), 6,0 and 8.8 kg (YWT), and 18.2 and 26.5 kg (EWT), respectively. The best performance was registered in calves born from dams aged 3-7 (CAG1) for Gudali and 8-10 (CAG2) for Wakwa. It is therefore necessary to take into account these significant effects to better assess calf performance.

■ INTRODUCTION

The potential of beef cattle production in Cameroon is high as cattle are found in all the ecological regions of the country (26). The cattle population was estimated at 4,361,500 head, representing about 61.3% of the total meat production (16). Unfortunately, about 60% of the national herd is kept under a husbandry system which presents high risks, is rural, extensive, nomadic, and is located where diseases and parasites abound (26). The cattle growth rate is low, fertility modest and mortalities quite high (5 to 10% for adults and 20% for calves). These mortalities have been associated with the high incidence of trypanosomosis (2). Factors that affect beef productivity include degradation of rangelands caused by overgrazing, climatic hazards caused by the variability, severity and length of the rainy and dry seasons, water scarcity, poor health facilities and socioeconomic problems. The role of the genetic and environmental effects in the determination of beef cattle production and productivity in Cameroon is therefore of great importance. However, studies on factors affecting growth performance are rare in the literature. Lhoste (11) investigated factors affecting preweaning growth performance of Gudali and Wakwa breeds using simply the raw means. Abassa *et al.* (1) and Tawah *et al.* (30) examined environmental factors affecting preweaning growth performance of both breeds using the least squares approach. However, these authors used only a portion of the data collected on both breeds. Besides, the role of the maternal effect was never included in the model. No further attempts have been made to extensively quantify genetic and environmental

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factors affecting preweaning and postweaning performance traits for the overall selection data. Genetic improvement of any breed within a given environment will depend on identifying the major environmental constraints to performance, on devising means to alleviate or control them, and on evaluating the breed for its adaptability to cope with constraints that cannot be readily controlled. Knowledge of these constraints will be useful in the modification of improvement strategies and/or adjustment of animals' records for reliable genetic evaluation of their performance. The aim of the present study was to use mixed model methodology to investigate and quantify factors that affect preweaning and postweaning growth traits in Gudali and Wakwa beef cattle in the tropical highlands of Cameroon.

■ MATERIALS AND METHODS

Experimental design and data collection

Breeding animals were obtained from two selection experiments. One involved a two-breed synthetic beef breed, the Wakwa, obtained from *inter se* matings of the first filial generation of American Brahman (50%) x Gudali (50%) crosses. The other involved recurrent selection of the indigenous purebred Gudali in an effort to enhance its beef production without any serious detrimental effects to its adaptation qualities. Breeding females (about 30 to 40) were annually reshuffled within breeds into various breeding herds. Breeding bulls were assigned randomly to these herds, while ensuring that inbreeding was minimized. The annual assignment of bulls to breeding herds was to ensure genetic connectedness across herds and years. The calves were ear-tagged and weighed at birth (BWT), and weighed monthly subsequently. Weights were registered in various herd-books of Adamawa maintained at the Wakwa Regional Research Centre. Weaning (WWT), yearling (YWT) and eighteen-month (EWT) weights were obtained from monthly weights at roughly eight, 12 and 18 months, respectively.

The experimental animals were maintained at the Wakwa Station for Animal Production of the Ministry of Livestock, Fisheries and Animal Industry and at the Wakwa Research Station of the Institute of Agricultural Research for Development of the Ministry of Scientific Research. The Wakwa Animal Production and Research Stations are located on the Adamawa highlands of Cameroon at an altitude of about 1100 m above sea level. The management system, pastures and climatic conditions have thoroughly been documented (6, 11, 13, 14, 20, 21, 27, 31).

Data were edited for valid pedigree information and consistency checks were made on dates, sex, herds, seasons, exact ages at weaning, yearling and eighteen months, and weight ranges. Consequently, the years 1985-1987 for preweaning traits in Gudali, and 1986 for those in Wakwa, and 1985-1988 for postweaning traits in both breeds were omitted because weight measurements for these years were not available. The valid data were classified according to sire, dam, sex, herd, season, calf birth year (CBY), cow age group (CAG) and exact ages at weighing at roughly eight months (WAGE), 12 months (YAGE) and 18 months (EAGE). Seasons were defined as reported by Tawah *et al.* (30): a five-month dry season from November to March and a seven-month rainy season from April to October. WAGE, YAGE and EAGE were calculated as the difference between a calf's birth date and its corresponding dates at weaning, yearling and eighteen months, respectively. The cow age group (CAG) was defined as the deviation of the dam's year of birth from the calf birth year (CBY). Three categories of CAG were defined: CAG1 for cows less than eight years, CAG2 for cows older than seven but less than 11 and CAG3 for cows older than 10 years.

Breed description

The Gudali cattle breed is popularly known as Peulh or Fulbe (Fulani) because of its predominance and importance to the Peulh pastoralists of the Adamawa Province of Cameroon (29). It is a short-horned zebu characterized by a large dewlap, a navel sheath in the females, a pendulous preputial sheath in the males, erect ears, and a well developed cervico-thoracic hump. Though the coat color is variable, it is predominantly brownish-white. The breed is fairly large with an average adult weight of about 552 and 307 kg for males and females, respectively. The height-at-withers, chest girth and scapulo-ischial length average 123, 187 and 128 cm, respectively, at adult age for both sexes (17). On the other hand, the Wakwa cattle breed is a two-breed synthetic derived from *inter se* matings of American Brahman x Gudali F1 animals (Prewakwa). The Wakwa type is characterized by a variety of coat colors, a broad but slightly convex face, long drooping ears, short broad based horns, an oval hump and a straight broad back. At about 30 months, males and females weigh on average 512 and 426 kg, respectively, and the height-at-wither, chest girth and scapulo-ischial length average 133, 140 and 147 cm, respectively (17). More details on the development of the Wakwa breed have been reported by Mandon (17) and descriptions of the breeds have been extensively documented (12, 15, 30, 31).

Statistical model and analytical techniques

Proc Mixed of the Statistical Analysis Systems Institute (25) was used to test the significance of fixed effects with sire effect considered as random. Data were analyzed with the multiple-trait derivative-free restricted maximum likelihood (MTDFREML) by Boldman *et al.* (4) using an animal model with animal and maternal effects fitted as random, sex, herd (H), season (S), calf birth year (C) and cow age group effects fitted as fixed, and exact ages at weaning, yearling and eighteen months fitted as linear covariates on weaning, yearling and eighteen-month weights, respectively. The animal model for breed/trait analyses was presented as follows:

$$Y_{ijklmno} = \mu + A_i + M_j + G_k + S_l + H_m + A_n + C_o + b(x_{ijklmnop} - \bar{X}) + e_{jklmno}$$

where $y_{ijklmno}$ = performance trait (BWT, ADG, WWT, YWT and EWT) for the i^{th} calf (animal) of sex k, calved in the l^{th} season within the o^{th} year by the j^{th} cow of the n^{th} age group and reared in the m^{th} herd

μ = overall mean; A_i = i^{th} direct animal effect; M_j = maternal effect of the j^{th} dam; G_k = fixed effect of the k^{th} sex (k = 1, 2); S_l = fixed effect of the l^{th} season of calving (l = 1, 2); H_m = fixed effect of the m^{th} herd (m = 1, 2...14 for Gudali, and l = 1, 2...7 for Wakwa); P_n = fixed effect of the n^{th} cow age group (n = 1, 2, 3); C_o = fixed effect of the o^{th} calf birth year (o = 68...88)

b = linear regression of calf weight (WWT, YWT or EWT) on age at weaning (WAGE), yearling (YAGE) and eighteen (EAGE) months, respectively; $x_{ijklmno}$ = exact age of i^{th} calf (days) at weaning, yearling or eighteen months; $\bar{X}$ = mean age at weaning, yearling or eighteen months, and $e_{ijklmno}$ = random error, assumed to be normally and independently distributed with a zero mean and variance of σ^2.

Best linear unbiased estimates (BLUE) and standard errors (SE) for each growth trait were computed with the program. The edited data structure on the number of progeny records per performance trait per breed and the number of sires and dams contributing to the progeny records, trait means (kg), standard deviations (SD) and coefficients of variation (CV) are presented in Table I.

Table I

Summarized data structure on random and fixed effects

Breed	Trait	Records	Mean	SD	CV	Sires	Dams
Gudali	BWT	2886	24.09	2.73	11.34	93	1137
	ADG	2732	0.52	0.12	23.14	93	1115
	WWT	2899	149.79	28.49	9.15	93	1181
	YWT	2098	159.12	28.04	17.64	82	1001
	EWT	1957	197.77	36.50	18.45	79	931
Wakwa	BWT	1793	24.90	3.14	12.62	60	659
	ADG	1656	0.57	0.12	21.11	60	639
	WWT	1838	161.65	29.54	18.27	60	710
	YWT	1372	170.70	27.71	16.23	53	570
	EWT	1328	213.65	37.38	17.50	53	579

CV = coefficient of variation; BWT = birth weight (kg); ADG = preweaning average daily weight gain (kg/d) ; WWT = weaning weight (kg); YWT = yearling weight (kg); EWT = eighteen-month weight (kg)

■ RESULTS AND DISCUSSION

Effects used in the estimation of BLUE and SE for preweaning and postweaning performance traits are presented in Tables II and III for the Gudali breed, and in Tables IV and V for the Wakwa breed.

Wakwa calves (Tables IV and V) performed better than Gudali calves (Tables II and III) for BLUE in all the traits studied. This observation is in agreement with those of Lhoste (12), Tawah (28), Tawah *et al.* (30) and Abassa *et al.* (1). This comparative advantage could be attributed to heterosis and complementarity of genes from the parental breeds: Brahman and Gudali.

Sex was a highly significant ($p < 0.001$) source of variation for BLUE on the various growth traits. On the average, male calves were 0.8 and 0.6 kg, 11.3 and 12.9 kg, 14.5 and 15.1 kg, and 13.4 and 11.9 kg heavier than female calves for BLUE for birth, weaning, yearling and eighteen-month weights and grew faster by 0.04 and 0.06 kg/day from birth to weaning in Gudali and Wakwa breeds, respectively. The significant effect of sex reported in the present study is in agreement with reports by Lhoste (12), Tawah *et al.* (30), and Abassa *et al.* (1) on preweaning growth performance traits in both breeds. The BLUE reported in this study agrees with the least squares means (LSM) reported by Tawah *et al.* (30) but are higher than LSM reported by Abassa *et al.* (1). The better performance of male over female calves was also reported on the preweaning weight of some beef cattle by other authors (3, 9, 10, 22, 24). The advantage of males over females may be attributed to hormonal differences in their endocrinological and physiological functions and to selection pressure that was more intense on male calves.

The effect of season on the performance traits was also highly significant ($p < 0.01$ or $p < 0.001$). Though calves born in the dry season had lower BLUE for birth weight than those born in the rainy season, the tendency was reversed for ADG, WWT, YWT, and EWT. The dry season calves performed better than the rainy season calves for BLUE by 19.00 and 21.7 kg, 6.0 and 8.8 kg, and 18.2 and 26.5 kg at weaning, yearling and eighteen months, and grew faster by 0.09 and 0.08 kg/day from birth to weaning in Gudali and Wakwa breeds, respectively. The significant heavier weaning BLUE and faster growth from birth to weaning for dry season calves compared to rainy season calves obtained in this study agree with those reported by Tawah (28) on the same breeds. The highly significant season effect on BLUE for birth weight, however, did not agree with a report by Abassa *et al.* (1) on the same breeds. However, the significant season effect on preweaning traits obtained in the present study is in agreement with reports by Kahi *et al.* (8) on crosses of Ayrshire, Brown Swiss and Sahiwal cattle in the lowland of tropical Kenya, and by Kassa-Mersha and Arnason (10) on Ethiopian Boran cattle. The highly significant effect of season could be attributed to seasonal variations in the total physical environment due to changes in the weather, which affected feed availability and disease incidence. About 84% of dry season calvings occurred between February and April, with about 69% of calvings occurring within the month of April alone (last month of the dry season). Consequently, most of the dams that calved in the dry season were conceived either in the earlier part of the dry season of the previous year or in the later part of the rainy season. During this period, the pastures are usually depleted, less nutritious. This state of nutritional stress results in weight loss and poor body condition of the pregnant dams, a state that is passed on to the calf through the prenatal developmental environment. The inherent nutritional stress is then reflected in the calf by a lower weight at birth in the dry season.

Late dry season calves and their dams are, however, exposed to the earlier part of the rainy season, characterized by young nutritious pastures, favorable for better body condition for the dam and higher milk production for calf consumption. The consequence is a higher calf growth leading to a higher weaning weight. This advantage is passed on to the postweaning performance of the calf.

On the other hand, most of the rainy season calvings (73%) occurred between April and June. Implicitly, most of the dams that calved in the rainy season were conceived either in the latter part of the dry season or earlier part of the rainy season of the previous year. The pregnant dams, therefore, benefited from better nutrition that resulted in better body conditions and higher BLUE. The comparative advantage is passed on to the calf during prenatal development. The inherent advantage is subsequently reflected in a higher BLUE for birth weight during the rainy season. However, as reported by Deese and Koger (5), and Hohenboken and Brinks (7), a higher nutritional environment conducive to early rapid growth in the dam usually results in a poor maternal performance, which is reflected in the progeny weaning weight. This poor maternal performance may, therefore, be responsible for the lower BLUE at weaning, yearling and eighteen months obtained for rainy season calvings.

The calf birth year (CBY) was found to be a highly significant ($p < 0.001$) source of variation for birth weight, average preweaning daily gain, weights at weaning, yearling and eighteen months.

Table II

Best linear unbiased estimates for preweaning growth traits in Gudali cattle

Effects	Num. records	BWT	Num. records	ADG	Num. records	WWT
Sex		***		***		***
Male	1412	24.51 (0.10)	1345	0.54 (0.004)	1435	154.79 (0.97)
Female	1474	23.69 (0.10)	1387	0.50 (0.004)	1464	143.49 (0.97)
Season		***		***		***
Dry	397	23.64 (0.14)	368	0.60 (0.006)	405	165.05 (1.41)
Rainy	2489	24.16 (0.07)	2664	0.51 (0.003)	2494	146.05 (0.69)
Herd		***		***		***
1	252	24.63 (0.18)	245	0.51 (0.007)	259	143.74 (1.74)
2	249	23.93 (0.18)	220	0.50 (0.008)	226	144.37 (1.87)
3	237	24.22 (0.18)	220	0.53 (0.008)	231	151.24 (1.79)
4	293	24.18 (0.17)	288	0.53 (0.007)	306	151.18 (1.62)
5	243	23.72 (0.18)	226	0.52 (0.008)	235	148.47 (1.78)
6	219	24.55 (0.19)	209	0.53 (0.008)	231	151.06 (1.83)
7	241	24.18 (0.18)	232	0.50 (0.008)	251	145.39 (1.78)
8	213	24.02 (0.19)	196	0.49 (0.008)	221	143.33 (1.92)
9	207	24.03 (0.20)	184	0.50 (0.009)	195	143.39 (1.99)
10	209	24.33 (0.19)	208	0.55 (0.008)	222	156.31 (1.86)
11	122	23.98 (0.25)	118	0.52 (0.011)	128	150.35 (1.36)
12	216	23.82 (0.19)	202	0.54 (0.008)	209	152.35 (1.88)
13	151	23.02 (0.23)	141	0.55 (0.010)	147	153.29 (2.30)
14	43	24.79 (0.42)	43	0.56 (0.018)	48	155.71 (2.92)
CBY		***		***		***
68	135	23.82 (0.24)	135	0.52 (0.010)	136	152.02 (2.38)
69	180	24.69 (0.21)	180	0.51 (0.009)	196	147.52 (2.04)
70	226	24.31 (0.20)	220	0.45 (0.008)	222	133.04 (1.96)
71	178	24.66 (0.21)	175	0.50 (0.009)	177	144.44 (2.12)
72	250	24.87 (0.20)	248	0.52 (0.008)	253	148.35 (1.81)
73	199	24.73 (0.24)	133	0.51 (0.010)	138	147.09 (2.33)
74	133	23.33 (0.21)	128	0.51 (0.010)	131	145.89 (2.35)
75	162	23.59 (0.21)	162	0.55 (0.009)	168	156.74 (2.05)
76	165	23.32 (0.20)	156	0.58 (0.009)	165	161.67 (2.07)
77	199	23.04 (0.21)	186	0.58 (0.009)	189	162.73 (2.04)
78	187	23.16 (0.21)	180	0.50 (0.009)	184	141.88 (2.06)
79	176	23.78 (0.21)	164	0.51 (0.009)	173	148.13 (2.12)
80	154	24.38 (0.22)	151	0.49 (0.010)	152	141.64 (2.22)
81	152	24.66 (0.23)	152	0.52 (0.010)	152	140.62 (2.28)
82	128	23.01 (0.25)	115	0.50 (0.011)	115	142.48 (2.56)
83	164	24.24 (0.22)	155	0.53 (0.009)	159	151.00 (2.15)
84	98	24.71 (0.27)	92	0.61 (0.012)	125	168.03 (2.40)
88					64	158.69 (3.40)
CAG		ns		ns		***
1	1570	24.11 (0.09)	1487	0.52(0.004)	1579	147.57 (0.89)
2	998	24.07 (0.10)	939	0.53(0.004)	997	150.68 (1.01)
3	318	24.07 (0.17)	306	0.52(0.007)	323	148.89 (1.62)
Maternal		***		***		**
WAGE						***

BWT = birth weight (kg); ADG = preweaning weight gain (kg); WWT = weaning weight (kg); CBY = calf birth year; CAG = cow age group; WAGE = weaning age (days)
*** $p < 0.001$; ** $p < 0.01$
ns = not significant

Table III

Best linear unbiased estimates for yearling and eighteen-month weights in Gudali cattle

Effects	Num. records	YWT	Num. records	EWT
Sex		***		***
Male	969	166.93 (1.13)	888	205 11 (0.97)
Female	1129	152.42 (1.08)	1069	191.68 (0.97)
Season		**		***
Dry	292	164.28 (1.60)	283	213.36 (1.41)
Rainy	1806	158.29 (0.79)	1674	195.14 (0.69)
Herd		***		***
1	162	155.04 (2.01)	148	193.43 (1.74)
2	180	157.84 (1.95)	171	195.45 (1.87)
3	179	159.28 (1.91)	169	199.69 (1.79)
4	227	164.10 (1.80)	213	204.54 (1.62)
5	172	156.43 (1.96)	153	196.87 (1.78)
6	157	154.73 (2.10)	157	191.58 (1.83)
7	149	157.65 (2.16)	142	199.77 (1.78)
8	147	157.14 (2.15)	138	197.27 (1.92)
9	156	149.70 (2.12)	149	190.40 (1.99)
10	154	164.63 (2.83)	141	199.96 (1.86)
11	77	160.77 (2.83)	63	199.79 (1.36)
12	150	165.07 (2.08)	135	202.35 (1.88)
13	128	163.13 (2.32)	122	198.85 (2.30)
14	60	167.25 (3.30)	56	199.29 (2.92)
CBY		***		***
68	133	159.72 (2.25)	127	198.69 (2.38)
69	173	141.82 (2.04)	174	184.65 (2.04)
70	210	143.29 (1.92)	195	185.44 (1.96)
71	125	154.70 (2.32)	105	185.77 (2.12)
72	208	158.31 (1.86)	191	189.83 (1.81)
73	130	151.57 (2.26)	113	180.64 (2.33)
74	81	151.86 (2.75)	79	198.24 (2.35)
75	164	171.99 (1.94)	165	209.72 (2.05)
76	123	176.16 (2.20)	135	243.39 (2.07)
77	165	166.33 (2.04)	159	187.64 (2.04)
78	131	149.72 (2.27)	110	180.09 (2.06)
79	112	156.81 (2.40)	105	196.77 (2.12)
80	60	167.07 (3.20)	55	216.47 (2.22)
81	22	167.00 (5.17)	22	202.82 (2.28)
82	67	153.16 (3.06)	71	200.82 (2.56)
83	122	175.47 (2.30)	92	218.26 (2.15)
84	72	192.22 (2.94)	59	223.98 (2.40)
CAG		ns		ns
1	1152	157.15 (1.02)	1091	196.88 (0.89)
2	736	161.79 (1.13)	687	199.99 (1.01)
3	210	160.59 (1.85)	179	194.70 (1.62)
Maternal		*		*
YAGE		***		
EAGE				ns

YWT = yearling weight (kg); EWT = eighteen-month weight (kg); CBY = calf birth year; CAG = cow age group; YAGE = yearling age (days); EAGE = eighteen-month age (days)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

ns = not significant

There was, however, no consistent trend over time for maximal performance. The inconsistency in performance from year to year probably resulted from the fact that environmental conditions, especially in Africa, in a specific year will seldom, if ever, be repeated. The significant ($p < 0.001$) year effect obtained in the present study is in agreement with reports by Rust and Van der Westhuizen (23) for Simmental calves, Kars *et al.* (9) for Nguni calves, Kahi *et al.* (8) for crosses of Ayrshire, Brown Swiss calves, Ahunu and Makarechian (3) for Herefords, beef synthetic (Angus, Charolais and Galloway) and crossbred (Herefords x beef synthetic) calves, and Kassa-Mersha and Arnason (10) for Boran calves. The significant effect of year on preweaning and postweaning growth performance traits may be explained in terms of rainfall pattern in Wakwa. There were fluctuations in the annual rainfall, which generally affected the quality and quantity of forage available for dam and calf. The quality and quantity of forage usually influence the quality and quantity of milk production in the dam, an essential component for calf growth. Non-systematic factors such as the introduction in latter years of supplementary feeding in the form of cottonseed cake and rice bran in the dry season could be responsible for fluctuations in growth patterns. Improvement in pastures and herd management as a result of improvement in herdsman skills over the years could equally contribute to the significant year effect. Possible changes in the genetic makeup of the animals during the long selection period (1968-1988) could equally be responsible for differences in growth.

The herd also significantly ($p < 0.001$) affected all performance traits. The herds were located within two main zones, Young Basalt (Vina zone) and Ancient Basalt (plateau zone). The Vina zone is a swampy woody area in which the grazing areas were fenced, thereby limiting grazing space for the animals. Although the swampy nature and thick forest of this zone provided the animals with forage all year round, it was at the same time a natural habitat and breeding ground for tsetse flies, the main trypanosomosis vectors. On the opposite, grazing areas found within the Ancient Basalt (plateau zone) were not fenced resulting in animals having access to more grazing land. Although the zone did not provide forage to the animals all year round, annual preparations of hay supplementation during the dry season partly compensated for the difference. Most of the herds with the best performance were located in the Ancient plateau zone (hilltop). Consequently, the significant herd effect could be attributed to variations in herd location, variations in the degradation level of grazing areas, stocking effect, variations in soil composition and pastures, variations in tsetse fly infestation, and overall differences in herd management and herdsman skills across seasons and years.

The effect of the cow age group was not significant ($P > 0.05$) for BLUE on BWT, preweaning daily weight gain and YWT. However, it significantly ($p < 0.01$ or $p < 0.001$) affected the WWT and EWT performance. Though the cow age group was not significant at birth, Gudali calves born of cows in CAG2 had lower birth weights but grew faster and attained higher weaning and postweaning performances (Tables II and III) compared to those in CAG1 and CAG3. On the other hand, Wakwa calves born of cows in CAG1 were heavier at birth compared to those born of cows in CAG2 and CAG3. They maintained this advantage from BWT to EWT. The results of this study differ from those reported by Lhoste (11), and Abassa *et al.* (1), but they agree with those from Mbah *et al.* (19). They also agree with those from Singh *et al.* (24), Kassa-Mersha and Arnason (10), and Kars *et al.* (9), but they differ from reports by Ahunu and Makarechian (3), and Mangus and Brinks (18). The reason for the faster growth rate for calves in CAG1 might be largely attributed to differences in milk production. The majority of cows in CAG1 were within the age

Table IV

Best linear unbiased estimates for preweaning growth traits in Wakwa cattle

Effects	Num. records	BWT	Num. records	ADG	Num. records	WWT
Sex		***		***		***
Male	903	25.04 (0.15)	845	0.65 (0.006)	953	167.83 (3.67)
Female	890	24.40 (0.15)	811	0.59 (0.006)	885	154.98 (3.63)
Season		***		***		***
Dry	175	24.71 (0.23)	160	0.65 (0.009)	211	180.88 (3.91)
Rainy	1618	24.90 (0.11)	1496	0.57 (0.005)	1627	159.15 (3.57)
Herd		***		***		***
15	310	25.38 (0.21)	296	0.55 (0.009)	317	170.00 (2.00)
16	257	24.41 (0.21)	236	0.57 (0.009)	269	159.77 (2.00)
17	305	25.28 (0.20)	288	0.59 (0.008)	317	162.47 (1.82)
18	251	23.50 (0.21)	227	0.57 (0.009)	256	167.90 (2.01)
19	305	25.23 (0.20)	281	0.56 (0.008)	320	161.65 (1.85)
20	259	25.81 (0.21)	232	0.57 (0.009)	247	158.89 (2.04)
21	106	23.74 (0.30)	96	0.59 (0.013)	112	160.72 (2.86)
CBY		***		***		***
68	146	25.44 (0.27)	146	0.53 (0.011)	151	155.70 (4.24)
69	154	26.50 (0.26)	154	0.57 (0.011)	167	163.58 (4.17)
70	158	25.61 (0.27)	155	0.54 (0.011)	163	155.29 (4.23)
71	56	26.76 (0.33)	83	0.57 (0.014)	87	164.48 (4.65)
72	128	26.01 (0.27)	119	0.58 (0.011)	126	164.29 (4.28)
73	147	25.64 (0.27)	89	0.58 (0.013)	94	162.69 (4.56)
74	101	24.40 (0.30)	86	0.56 (0.013)	94	157.57 (4.51)
75	77	24.60 (0.34)	77	0.55 (0.014)	86	157.72 (4.60)
76	109	24.91 (0.28)	102	0.62 (0.011)	113	172.02 (4.32)
77	119	23.22 (0.29)	112	0.58 (0.012)	115	163.09 (4.37)
78	113	22.14 (0.29)	102	0.56 (0.012)	110	159.09 (4.40)
79	96	23.19 (0.31)	91	0.56 (0.013)	97	157.52 (4.51)
80	112	24.74 (0.30)	110	0.56 (0.012)	112	158.96 (4.42)
81	92	24.60 (0.31)	89	0.57 (0.013)	92	152.71 (4.59)
82	59	24.76 (0.38)	53	0.57 (0.016)	58	156.52 (5.01)
83	53	24.34 (0.41)	50	0.60 (0.017)	51	167.33 (5.20)
84	35	24.94 (0.48)	30	0.61 (0.021)	35	170.31 (5.76)
85	8	23.50 (1.01)	8	0.70 (0.040)	8	183.50 (10.3)
87					52	194.42 (4.81)
88					27	164.70 (6.45)
CAG		ns		ns		***
1	270	25.45 (0.20)	252	0.58 (0.008)	288	165.41 (3.86)
2	1258	24.87 (0.13)	1162	0.57 (0.005)	1291	162.08 (3.56)
3	265	24.48 (0.21)	242	0.55 (0.009)	259	155.31 (3.91)
Maternal		***		***		***
WAGE						***

BWT = birth weight (kg); ADG = preweaning weight gain (kg); WWT = weaning weight (kg); CBY = calf birth year; CAG = cow age group; WAGE = weaning age (days)
*** $p < 0.001$
ns = not significant

Table V

Best linear unbiased estimates for yearling and eighteen-month weight in Wakwa cattle

Effects	Num. records	YWT	Num. records	EWT
Sex		***		***
Male	709	178.00 (1.54)	652	219.72 (2.07)
Female	663	162.89 (1.53)	676	207.80 (1.95)
Season		***		***
Dry	125	178.72 (2.42)	130	237.52 (3.15)
Rainy	1247	169.90 (0.96)	1194	211.06 (1.27)
Herd		***		***
15	273	168.24 (2.02)	264	207.89 (2.69)
16	256	170.50 (1.93)	242	214.30 (2.63)
17	168	179.13 (2.27)	164	222.30 (3.00)
18	174	162.58 (2.22)	166	210.90 (3.00)
19	234	168.81 (2.03)	222	209.11 (2.75)
20	209	173.76 (2.09)	206	216.83 (2.76)
21	58	179.86 (3.55)	64	225.45 (4.55)
CBY		***		***
68	141	171.28 (2.58)	142	215.54 (3.44)
69	150	160.72 (2.45)	148	208.22 (3.29)
70	156	169.22 (2.47)	147	218.24 (3.33)
71	67	175.46 (3.33)	65	196.57 (4.53)
72	109	172.84 (2.63)	105	210.88 (3.56)
73	87	160.44 (2.95)	79	194.65 (4.09)
74	66	158.50 (3.25)	63	210.38 (4.43)
75	86	178.95 (2.91)	88	220.77 (3.83)
76	89	192.46 (2.69)	92	256.65 (3.55)
77	107	176.76 (2.72)	101	194.21 (3.71)
78	63	161.60 (3.41)	60	202.18 (4.65)
79	58	155.34 (3.53)	53	205.28 (4.87)
80	73	176.21 (3.23)	46	217.19 (5.19)
81	42	174.60 (3.97)	58	222.34 (4.54)
82	26	158.42 (5.03)	32	207.69 (6.06)
83	36	182.53 (4.27)	28	232.54 (6.43)
84	16	184.69 (6.25)	21	236.76 (7.33)
CAG		ns		*
1	656	171.04 (1.47)	639	215.87 (1.93)
2	534	170.66 (1.60)	511	212.56 (2.12)
3	182	169.62 (2.22)	178	206.81 (2.94)
Maternal		*		*
YAGE		***		
EAGE				***

YWT = yearling weight (kg); EWT = eighteen-month weight (kg);
CBY = calf birth year; CAG = cow age group; YAGE = yearling age (days);
EAGE = eighteen-month age (days)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

ns = not significant

range when their milk production was at a peak. The calves, therefore, benefited from this high milk production, a positive attribute for rapid calf growth and higher weight gain.

In addition, the maternal effect was a significant ($p < 0.05$ or $p < 0.001$) source of variation for growth performance in both Gudali and Wakwa breeds. This can be attributed to the fact that preweaning development of the calf is greatly influenced by maternal genetic and environmental variations (7), especially when the calf suckles its dam from birth to weaning and beyond. The growth performance of the calf will therefore be determined by the dam's potential for milk production, by any other related maternal behavior, and by all factors that pertain to motherhood. These factors include among others regular reproduction, gestation length, trouble-free calving, mothering ability, foraging ability, temperament and immunity of calf, and adaptation to adversity.

■ CONCLUSION

Maternal, sex, herd, season of calving, calf birth year effects, exact ages at weaning, yearling and eighteen months as covariates were significant sources of variations for BLUE on preweaning and/or postweaning performance traits in both Gudali and Wakwa beef cattle in Cameroon. The effect of the cow age group, although not significant at birth and on average preweaning gain, was significant at weaning and yearling performance for both breeds. These significant effects should therefore be taken into consideration in the estimation of genetic parameters and evaluation of the genetic merit of an individual animal during selection.

Calves born in the dry season though lighter than those born in the rainy season had the advantage of growing faster and being heavier at weaning, yearling and eighteen months. It may be therefore necessary in smaller husbandry systems to design a breeding program whereby cows calve towards the end of the dry season. Late dry season calving would reduce dystocia incidence. The cows would also benefit from earlier rainy season nutritious pastures, favorable for higher milk production and optimum profitability as a result of rapid growth and heavier calves at weaning, yearling and eighteen months.

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Résumé

Ebangi A.L., Erasmus G.J., Mbah D.A., Tawah C.L., Messine O. Facteurs affectant les performances de croissance chez les bovins à viande de pure race Goudali et croisés Wakwa dans un environnement tropical

Des données relatives aux performances présevrage et postsevrage de veaux de race pure Goudali et demi-sang Wakwa ont été collectées au Centre de recherche agricole pour le développement de Wakwa, Ngaoundéré, Cameroun. Ces données ont été analysées à l'aide de procédures de modèle mixte pour déterminer les facteurs affectant les performances. Les résultats ont montré que les effets maternel, du sexe, du troupeau, de la saison et de l'année de naissance, de l'âge au sevrage (WAGE), de l'âge exact (jours) aux pesées à un an (YAGE) et à 18 mois (EAGE) ont été significatifs ($P < 0,01$ ou $P < 0,001$) sur les performances présevrage et/ou postsevrage. Les veaux mâles ont eu des performances supérieures à celles des femelles chez les Goudali et les Wakwa, respectivement de 0,8 et 0,6 kg pour le poids à la naissance (BWT), de 11,3 et 12,8 kg pour le poids au sevrage (WWT), de 14,5 et 15,1 kg pour le poids à un an (YWT), de 13,4 et 11,9 kg pour le poids à 18 mois (EWT), et une croissance présevrage plus rapide de 0,04 et 0,06 kg/jour. Les veaux nés en saison sèche ont été plus lourds que les veaux nés en saison pluvieuse chez les Goudali et les Wakwa, respectivement de 19,0 et 21,7 kg (WWT), de 6,0 et 8,8 kg (YWT), et de 18,2 et 26,5 kg (EWT). Les meilleures performances ont été enregistrées chez les veaux nés de femelles âgées de 3 à 7 ans (CAG1) chez les Goudali et chez les veaux nés de femelles âgées de 8 à 10 ans (CAG2) chez les Wakwa. Pour une meilleure évaluation des performances des veaux, il est nécessaire de prendre en considération ces effets significatifs.

Mots-clés : Bovin Goudali – Bovin Wakwa – Performance animale – Facteur de croissance – Cameroun.

Resumen

Ebangi A.L., Erasmus G.J., Mbah D.A., Tawah C.L., Messine O. Factores que afectan el rendimiento del crecimiento en ganado de carne Gudali puro y Wakwa doble raza artificial, en medio tropical

Se colectó información sobre el rendimiento pre y post destete en terneros de carne, de raza Gudali pura y Wakwa doble raza artificial, en el Centro de Investigación Agronómica, Wakwa, Ngaoundere, Camerún. Los datos fueron analizados mediante un procedimiento de modelos mixtos, esto con el fin de determinar los factores que afectan el rendimiento. Los resultados mostraron que los factores materno, sexo, hato, época y año de nacimiento, edad al destete (WAGE), peso exacto (en días) a la pesada para terneros de un año (YAGE) y de dieciocho meses (EAGE) afectaron en forma significativa ($P < 0,01$ o $P < 0,001$) el rendimiento pre y/o post destete. Los terneros machos tuvieron un mejor rendimiento que las hembras en las razas Gudali y Wakwa, con 0,8 y 0,6 kg para el peso al nacimiento (BWT), 11,3 y 12,8 kg para el peso pre destete (WWT), 14,5 y 15,1 kg para el peso al año (YWT), 13,4 y 11,9 kg para el peso a los dieciocho meses (EWT) y para el crecimiento pre destete de 0,04 y 0,06 kg/día, respectivamente. Los terneros nacidos durante la estación seca fueron más pesados que aquellos nacidos durante la estación lluviosa para las razas Gudali y Wakwa, con índices de 19,0 y 21,7 kg (WWT), 6,0 y 8,8 kg (YWT), y 18,2 y 26,5 kg (EWT), respectivamente. El mejor rendimiento se registró en terneros nacidos de hembras con edades entre los 3 y los 7 años (CAG1) para los Gudali y 8-10 (CAG2) para los Wakwa. Por lo tanto, estos factores deben ser tomados en consideración para una mejor evaluación del rendimiento del ternero.

Palabras clave: Ganado bovino Gudali – Ganado bovino Wakwa – Desempeño animal – Factor de crecimiento – Camerún.