Global Journal of Animal Breeding and Genetics

ISSN: 2408-5502 Vol. 3 (3), pp. 129-138, March, 2015. © Global Science Research Journals
http://www.globalscienceresearchjournals.org/

Full Length Research Paper

Effect of creep feeding of different protein sources on growth studies of bull calves in a rainforest environment

***E. N. Nwachukwu[1], C. C. Ogbu[2], M. N. Ndubisi[1] and E. C. Obioma[1]**

[1]Department of Animal Breeding and Physiology, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State.
[2] Department of Animal Health and Production, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Abia State

Accepted 25 February, 2015

Abstract

Objectives of the study were to evaluate the effects of creep feeding and sources of crude protein on growth performance of beef bull calves. Nine crossbred (N'dama x White Fulani) nursing bull calves, 3 months of age, and 49.67 ± 1.86 to 52.04 ± 1.86 kg body weight were used for the study. Two diets: A and B having groundnut cake and soybean meal as main sources of crude protein, respectively were formulated for the study. The animals were randomly allotted to three treatments namely T_1 or control (no creep feeding, NCF), T_2 or creep feeding with diet A (CFA), and T_3 diet B (CFB). Creep feed was offered between 06:00 and 09:30h daily. Thereafter, the animals were allowed to graze alongside and suckle their dam. Concentrate feeding was increased by 0.25 kg daily until 1.0 kg/animal/day. Calves belonging to the same treatment were fed separately but within sight of their dams and other calves. Data analyzed include body weight (BWT), body length (BLT), height at withers (HTW), heart girth (HGT), head circumference (HDC) and body condition score (BCS) at different ages. Gain in BWT (BWG), linear body traits and BCS were computed for each group. Results showed significant (P<0.05) effect of creep feeding and source of crude protein on BWT, BWG, and BCS but not on linear body traits. Calves fed CFB were significantly heavier than those fed CFA which in turn was superior to the control from week20 to 28 of age. Significant and positive correlation existed between BWT and HTW, BLT and HGT, BLT and BWT, BWT and BCS, and BLT and HDC at different age periods while HTW was negatively related to BCS. It was concluded that creep feeding influenced growth parameters and BCS of calves and that soybean meal was better than groundnut cake as source of crude protein for creep ration in calves.

Keywords: Creep feeding, growth traits, protein sources, body condition score, hybrid beef calves.

INTRODUCTION

Growth has a crucial impact on the economic value of animals. Growth rate determines the ultimate weight and size of cattle at maturity as well as carcass yield on slaughter. Growth is an increase in size and functional capabilities of tissues and organs of the body. In cattle breeding programmes, growth traits like body weight, weight gain and feed efficiency are considered as selection criteria. Linear body parameters such as body length, height at withers, heart gait, etc are also important growth indices and are positively associated with body

*Corresponding author. Email: ennwachuk@yahoo.com

weight (Otoikhian et al*.,* 2008; Ozkaya and Bozkurt, 2008; 2009). They are used to predict body weight in animals including cattle (Ozkaya and Bozkurt, 2008; 2009). Body condition score on the other hand is useful in assessing energy reserves, marbling, and carcass quality. It could also be used to assess growth performance (Assan, 2013). In order to attain the genetic potential for growth, young animals must be fed rations that are adequate and balanced in addition to the dam's milk. For calves, preweaning performances are very important determinants of overall performance at weaning and post weaning (Myer et al., 1999; Arthingthon et al*.,* 2008). Pre-weaning performance enables early assessment of the economic value of the animal and the dam or sire (or both), and the assignment of roles subsequently. Calf performance may be considered a trait of the cow in successive lactations (Vinoles et al*.,* 2013) and prediction of the future most probable producing ability (MPPA) of a cow with respect to preweaning growth traits of her calves is of immense advantage. Cow productivity is a trait of the cow which depends on the weaning rate and weaning weight of a cow's calves over a number of lactations (Vinoles et al*.,* 2013).

Provision of adequate and good quality feed for cattle feeding is a major constraint to cattle production in Nigeria and sub-Saharan Africa (Sowande et al*.,* 2008). Normadism and Pastoralism are production systems in response to variations in geographical distribution of forage resources and seasonal variation in availability of grazing and water resources for animal (cattle) production. The shortage of grasses for feeding of cattle becomes even more acute during the dry season when grasses are both in short supply and low in quality (Ensminger, 1991; Sowande et al*.,* 2008). Pastures with low nutrient quality, which is most common in late summer, or low nutrient quantity, which is common in winter or during drought, cannot meet calves' nutrient needs for maximum growth (Parish and Rhinehart, 2009). Scarcity of feed resources affects both cow and calf performances: low milk production, shorter lactation period, and poor growth and development of the calf. Generally milk produced by cows is insufficient to meet the nutritional needs of the calf and support maximum growth and development (Shike et al*.,* 2007). Parish and Rhinehart (2009) stated that milk production in beef cows peaks at about 2 months after calving and decrease subsequently and that milk from the lactating cow offers only about half the nutrient that a 3- to 4-month old calf needs for maximum growth. These indices indicate that as cows' milk yield decreases, calf nutritional demand increases. In order to bridge this gap, calves are given access to supplemental feeding (creep feeding). Weaning is a stressful event in the life of the calf (Lynch *et al.,* 2012). The stress of weaning manifests in altered behavior (Price et al*.,* 2003; Entiquez et al*.,* 2010), secretion of hormonal mediators of stress (Blanco *et al.,* 2009), and altered immune functions (Arthington et al*.,* 2008; Enriquez et al*.,* 2011) evident post weaning. Even though proper nutrition generally cannot prevent stress or infection, it can assist in preparing the animal for a period of stress, can decrease the adverse effect of stress and can enhance recovery from stressful periods. From the foregoing, methods of increasing the availability of nutrients for the cow-calf pair would be of benefit for increasing the productivity of the beef herd (Vinoles et al*.,* 2013). The effect of pre-weaning concentrate feeding on physiological and immunological responses of calves has also been studied (Lynch *et al.,* 2012). Generally, proper nutrition to the calf will help prevent the immunosuppression caused by stress and thus enhance the health and performance of the animal. Creep feeding is advocated as a means of reducing weaning stress in calves through the familiarization to a palatable feed, such as concentrates. It has been reported to decrease morbidity in feedlots (Myers et al*.,* 1999). Lardy (2008) established that creep fed calves usually suffer less set back at weaning and tend to adapt to feedlot ration quicker than calves not creep fed. In herds where milk production is low or the majority of cows are calf heifers or very old animals, creep feeding could make the difference in calf performance.Creep feeding therefore compensate for decreasing milk yield and forage scarcity and improves calf weaning weights (Lynch et a*l.,* 2013).
Studies (Anderson, 2008; Parish and Rhinehart, 2009) have shown that the source and type of creep feed, amount consumed, and length of time calves received creep feed all influence growth and carcass quality grade of the calves. Furthermore, calves suckling poor milking cows and/or grazing poor quantity and quality forages are reported to benefit more from creep feeding than those on good dam milk and/or good forage supply (Cole, 1996; Anderson, 2008; Parish and Rhinehart, 2009). Data show that calves need to be on creep feed for about 80 days to increase quality grade and that weaning at 80 days bring reproductive benefits to the cow and performance and carcass benefits for the calf (Anderson, 2008). Shikeet al*.* (2007) reported 21% higher gain in creep-fed calves and 5.8% higher gains in the finishing phase than non-creep-fed cattle. Over the entire trial, creep-fed cattle had 9.7% higher gain, were more efficient (0.181 vs 0.175), and spent 11 fewer days in the feedlot than non-creep-fed cattle. Creep-fed cattle had 18.5 kg heavier carcass weight, and 4% larger rib-eye (Shike et al*.,* 2007).A number of studies (Mayo et al*.,* 2002; Parish and Rhinehart, 2009; Stewart, 2013) have indicated some adverse effects of creep feeding. Creep feeding is reported to impact negatively on the economy of the cow-calf enterprise especially when there are poor indications of the need for creep feeding (Parish and Rhinehart, 2009) namely good dam milk and adequate forage quality and availability. Thus, prior assessment of the cost of

creep feed, cost per kilogramme gain, the efficiency of gain, and the price of weaned calves has been advocated before embarking on creep feeding (Cole, 1996; Parish and Rhinehart, 2009).Creep feeding is not currently practiced in the cattle herd of Michael Okpara University of Agriculture, Umudike. This study was therefore designed to evaluate the effects of creep feeding using two creep rations, differing in source of crude protein, on growth (body weight and linear body parameters) and body condition score of nursing crossbred bull calves grazing local grasslands alongside their dams. We hypothesize (based on observed forage dynamics and milk yield of the beef cows) that creep feeding could be beneficial to improve growth rate, weight gain, weaning weight and body condition score of the calves.

Materials and Methods

The study was carried out at the Cattle Unit of Michael Okpara University of Agriculture; Umudike Teaching and Research farm located on latitude 05^o29^I North and longitude 07^o31^I east and on an altitude of 122m above sea level. The area is typical humid with annual mean rainfall of 2169.8mm, rainy day range of 148-155 days, daily mean ambient temperature of 26^oC, and relative humidity range of 50-72% during the rainy season (NRCRI, 2004, unpublished).

Experimental Animals and management protocols

Nine crossbred nursing bull calves, 3 months of age, and weighing 49.67 ± 1.86 to 52.04 ± 1.86kg were used for the study. Two diets namely diet A having groundnut cake as main source of crude protein and diet B having soybean meal as main source of crude protein were formulated for the experiment. The two diets were formulated to contain similar crude protein and energy levels. The animals were weighed and then randomly allotted to one of three treatments (T) (3 calves/treatment) namely T_1, control (no creep feed, NCF), T_2, creep feeding with diet A (CFA), and T_3, creep feeding with diet B (CFB). Each calf in a treatment served as a replicate. Calves were fed the creep diet between 06:00 and 09:30h daily. Thereafter, the calves were allowed to graze and suckle their dams in the farm pasture area. The allowance of concentrate was increased in increments of 0.25 kg daily until 1.0 kg of concentrate per animal daily was attained. Calves belonging to each of the treated groups were fed separately but within sight of their dam. Calves were fed once daily using a wooden feeder long and wide enough to allow the animals feed simultaneously. All calves in treatment 2 and 3 participated in the consumption of the appropriate creep feed. Feed intake was not computed for the control group since they were grazed without supplementation.

Data collection

Body weight: The calves were weighed at the beginning of the study and at monthly intervals and values were recorded in kilogrammes (kg).Daily gain in body weight was calculated by dividing the difference between consecutive body weight values by the number of days in the interval.

Linear body parameters: The linear body parameters were measured using the Tailor's tape and recorded in centimeters (cm). Body length (BLT) was measured as the distance from the point of shoulder to the ischiadicum (i.e., from sternum or manubrium to the tuber ischiadicum). Height at withers (HTW) was measured as the distance from the ground beneath the animal to the top of the whithers directly above the centre of the shoulder. The heart girth (HGT) was measured as the minimal circumference around the body immediately behind the front shoulder. The head circumference (HDC) was measured as the circumference of the broadest region of the head. Daily gain in the linear body parameters was calculated as the difference between consecutive values divided by the number of days in the interval.

Body condition score (BCS): This was determined monthly by physical examination of each calf and scoring was based on the Scottish body condition scoring system (Agra Point International, 2003). The system consists of five grades determined by assessment of the degree of fat covering in the loin area between the hook (hip) bone and the last rib. Depending on the fat covering a score (subjective) of between 1 (very thin) and 5 (very fat) was assigned to each calve in the experiment. Thus an animal with very prominent (visible) spine, individual ribs and tail head (no fat cover) received a score of 1. A score of 2 indicated some fat covering of individual ribs and tail head but these structures were still felt by mare touch. A score of 3 was given to an animal whose short ribs were felt by firm pressure and whose tail head had fat cover that was easily felt. An animal whose short ribs could not be detected even with firm pressure and with obvious fat deposit around tail head received a score of 4 while a score of 5 was assigned to an animal whose characteristic bone structure was not noticeable, and tail head a loose fold of flesh. Animals that fell in between these classes received intermediate scores such as 1.5, 2.5, 3.5, etc. Daily changes in body condition score was calculated as the difference between two consecutive scores divided by the number of days in the interval.

Data Analysis

Data collected were subjected to Multivariate Analysis of Variance (MANOVA) using the SPSS computer software

Table 1: Percentage and proximate composition of creep feed ration

Ingredient	Diet A	Diet B
Maize offal	45	45
Brewer's dried grain	18.5	18.5
Palm kernel cake	18	18
Soyabean meal	-	15
Groundnut cake	15	-
Molasses	2	2
Bone meal	1.0	1.0
Salt	0.5	0.5
Total	100	100
Proximate composition (dry matter basis)		
Dry matter (%)	91.04	90.73
Crude protein (%)	19.30	19.18
Crude fibre (%)	7.80	7.18
Ether extract (%)	6.50	6.91
Nitrogen free extract (%)	53.50	50.70
Ash (%)	5.94	6.76
Energy (Kcal ME/kg)	3300.50	2290.90

Table 2: body weight values of crossbred beef bull calves fed or denied creep feeding

Body weight (kg)	NCF	CFA	CFB	SEM
BWT_{12}	52.04	51.67	49.67	1.86
BWT_{16}	57.33^{ab}	62.33^{b}	57.04^{b}	1.47
BWT_{20}	64.21^{b}	66.30^{b}	77.40^{a}	1.60
BWT_{24}	67.67^{c}	76.67^{b}	88.47^{a}	1.42
BWT_{28}	72.12^{c}	83.42^{b}	97.50^{a}	1.59
Daily gain in body weight (BWG, kg)				
BWG_{16}	0.19	0.37	0.26	0.09
BWG_{20}	0.25^{a}	0.14^{a}	0.73^{b}	0.05
BWG_{24}	0.12^{a}	0.37^{b}	0.40^{b}	0.04
BWG_{28}	0.16	0.24	0.32	0.08
Overall gain (kg)	20.17^{a}	31.43^{b}	47.83^{c}	2.36
Overall gain (%)	39.21^{a}	60.75^{b}	96.76^{c}	6.68

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05); BWT_i: body weight at the i^{th} age in weeks, BWG_i: body weight gain at the i^{th} age in weeks, NCF: no creep feeding, CFA: creep fed with diet A, CFB: creep fed with diet B, SEM: standard error of mean.

to compare treatment effects. Effects were accepted as significant at the 95% probability level. Significantly different means were separated using the Duncan New Multiple Range Test in SPSS. Pearson correlation analysis was performed to ascertain the association between pairs of the traits measured.

RESULTS AND DISCUSSION

The percentage and proximate composition of the creep feed rations employed in the present study is presented in Table 1 while Table 2 presents the body weight performance of the experimental birds across the age periods.

Calves that received creep feeding were heavier from 20 to 28 weeks (5 - 7 months) of age compared to the non supplementedcontrol group (NCF). Generally, calves fed the soybean diet (CFB) were significantly (P<0.05) heavier than those fed the groundnut cake concentrate (CFA) which in turn surpassed those of the control (77.40 vs 66.30 vs 64.21 kg,SEM 1.60, P<0.05 at wk 20; 88.47vs 76.67 vs 67.67 kg, SEM 1.42, P<0.05 at wk 24 and 97.50 vs 83.42 vs 72.12 kg, SEM 1.50, P<0.05 at wk 28). Table 2 also showed that body weight gain (BWG) differed significantly (P<0.05) among the experimental groups. Again calves creep-fed with diet B (CFB) gained significantly higher than those of A (CFA) and the control at wk 20 (0.73 vs 0.14 and 0.25kg, SEM 0.05) while the creep-fed groups were similar in daily weight gain at wk 24 but significantly (P<0.05) surpassed those of the control (NCF) at this age (0.40 and 0.37 vs 0.12 kg, SEM 0.04). There were no significant differences in daily weight gain between calves fed diet A and the control at wk 20 and among the experimental groups at wks 16 and 28.

Average daily weight gain across the trial period was 0.18, 0.28, and 0.43kg for control, CFA, and CFB groups, respectively. Furthermore, calves fed the creep diets gained significantly more in body weight over the trial period than non creep fed calves. Calves fed diet B (CFB) had the highest overall body weight gain of

Table 3: Body length values of crossbred beef bullcalves fed or denied creep feeding

Body length (cm)	NCF	CFA	CFB	SEM
BLT_{12}	87.67	84.03	79.33	1.77
BLT_{16}	91.02	87.83	86.33	1.87
BLT_{20}	94.67^{ab}	93.33^{b}	98.30^{a}	1.30
BLT_{24}	98.67	99.10	97.50	1.77
BLT_{28}	99.67	102.10	101.50	2.22
Gain in body length (GBLT, cm)				
$GBLT_{16}$	0.13	0.14	0.25	0.06
$GBLT_{20}$	0.13^{a}	0.20^{a}	0.43^{b}	0.04
$GBLT_{24}$	0.14	0.21	0.00	0.07
$GBLT_{28}$	0.04	0.11	0.14	0.12
Overall gain (cm)	12.20	18.07	22.17	3.09
Overall gain (%)	13.97	21.57	28.26	4.29

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05); BLT_i: body length at the i^{th} age in weeks, $GBLT_i$: daily gain in body length at the i^{th} age in weeks, NCF: no creep feeding, CFA: creep fed with diet A, CFB: creep fed with diet B, SEM: standard error of mean.

Table 4: Height at withers of crossbred beef bull calves fed or denied creep feeding

Height at withers (cm)	NCF	CFA	CFB	SEM
HTW_{12}	56.67	58.05	54.33	1.42
HTW_{16}	61.67	51.52	57.33	1.99
HTW_{20}	71.33	69.67	67.50	1.34
HTW_{24}	85.67	81.05	80.50	2.19
HTW_{28}	86.67	82.10	82.10	2.51
Daily gain in height at withers (GHTW, cm)				
$GHTW_{16}$	0.18	0.12	0.11	0.08
$GHTW_{20}$	0.35	0.29	0.36	0.03
$GHTW_{24}$	0.51	0.41	0.45	0.08
$GHTW_{28}$	0.04	0.04	0.07	0.15
Overall GHTW (cm)	30.00	24.03	27.77	3.38
Overall GHTW (%)	52.96	41.51	51.85	7.07

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05); HTW_i: Height at withers at the i^{th} age in weeks, $GHTW_i$: daily gain in height at withers at the i^{th} age in weeks, NCF: no creep feeding, CFA: creep fed with diet A, CFB: creep fed with diet B, SEM: standard error of mean.

47.83kg or 96% increase in weight which was significantly (P<0.05) higher than the 31.43kg or 60.75% for calves fed diet A. Calves in the control had the least overall body weight gain of 20.17kg or 39.21% increase over the period. The significantly higher BWT, daily weight gain and overall weight gain observed for the creep fed calves is in agreement with Shike et al. (2007) and Parish and Rhinehart (2009). Parish and Rhinehart (2009) stated that the weaning weight difference between creep and non-creep fed calves can approach 100lb (~45kg) while Shike et al. (2007) reported that creep feeding resulted in additional gain of about 21% higher body weight gain in creep fed calves compared to non-creep fed animals. These workers also reported heavier carcass weight of 18.5kg in creep fed calves over that of non creep fed animals. In the present study, calves fed groundnut cake as source of protein gained about 36% higher than the control while calves fed the soymeal ration gained about 58% more than the control animals. The significantly lower body weight observed for the calves in the control group showed that the calves were on suboptimal nutrition while the very high gain in body weight among creep fed calves showed that creep feeding was necessary to achieve optimal growth performance in those animals. The higher body weight and body weight gain of calves fed soymeal as source of protein compared to those fed GNC could mean that the soymeal diet was better utilized by the calves. The experimental animals were predominantly similar in body length (BLT) across the age periods (Table 3). The treated groups differed significantly (P<0.05) in BLT only at wk 20 (5 months of age) with the group fed diet B (CFB) having a higher value for BLT compared to those fed diet A (CFA). Calves in the control had similar BLT with those that received creep feeding. Similarly, daily gain in BLT differed significantly (P<0.05) between the study groups only at wk 20 with calves fed diet B surpassing those of diet A as well as the non supplemented group (control). Calves fed on A and those of the control were similar in gain in BLT at this age. Following the same trend as for BLT, daily gain in BLT did not differ significantly among the experimental groups at wks 12, 16, 24 and 28. Overall gain in BLT and percent gain in BLT did not also differ significantly between the experimental groups.

Table 5: Heart girth of crossbred beef bull calves fed or denied creep feeding

Heart girth (cm)	NCF	CFA	CFB	SEM
HGT_{12}	88.33	83.04	79.03	1.78
HGT_{16}	91.33	86.67	83.33	2.91
HGT_{20}	96.50	92.33	96.20	3.37
HGT_{24}	102.10	98.10	101.10	2.02
HGT_{28}	103.33	100.10	82.10	2.51
Gain in heartgirth (GHGT, cm)				
$GHGT_{16}$	0.18	0.12	0.11	0.08
$GHGT_{20}$	0.35	0.29	0.36	0.03
$GHGT_{24}$	0.51	0.41	0.45	0.08
$GHGT_{28}$	0.04	0.04	0.07	0.15
Overall (cm)	15.00^{a}	17.07^{ab}	24.47^{b}	2.64
Overall (%)	16.97^{a}	20.55^{ab}	31.29^{b}	3.78

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05); HGT_i: Heartgirth at the i^{th} age in weeks, $GHGT_i$: daily gain in heart girth at the i^{th} age in weeks, NCF: no creep feeding, CFA: creep fed with diet A, CFB: creep fed with diet B, SEM: standard error of mean.

Table 6: Head circumference of crossbred bull calves fed or denied creep feeding

Head circumference (cm)	NCF	CSA	CSB	SEM
HDC_{12}	51.04	50.04	50.33	1.46
HDC_{16}	54.33	53.67	52.73	2.45
HDC_{20}	59.33	58.01	59.75	1.77
HDC_{24}	61.33	62.75	62.75	2.71
HDC_{28}	63.33	64.10	64.40	2.21
Gain in head circumference (GHDC, cm)				
$GHDC_{16}$	0.12	0.13	0.09	0.08
$GHDC_{20}$	0.18	0.16	0.25	0.07
$GHDC_{24}$	0.07	0.17	0.11	0.13
$GHDC_{28}$	0.07	0.05	0.06	0.12
Overall (cm)	12.27	14.07	14.07	2.07
Overall (%)	24.23	28.02	28.13	4.44

NCF: no creep feeding, CSA: creep fed with diet A, CFB: creep fed with diet B, HDC_i: head circumference at the i^{th} age in weeks, $GHDC_i$: daily gain in head circumference at the i^{th} age in weeks, SEM: standard error of mean.

Table 4 showed that there were no significant differences among the experimental groups in height at withers (HTW), and in daily gain in HTW (GHTW) across the age periods as well as in overall gain and percentage gain in HTW while Table 5 showed that heart girt (HGT) significantly (P<0.05) differed only in overall gain and percentage gain between the experimental groups.

For these parameters, calves fed on CFB had higher overall gain and percentage gain compared to calves in the control group. The supplemented groups were similar in these parameters. So also the control and calves fed on CFA. A similar result as for HTW was obtained for head circumference (HDC) which did not differ significantly between treatments in any of the measured variables across the age periods (Table 6).

The predominant non significant differences in linear body parameters (BLT, HTW, HTG, and HDC) between treatments could indicate that these traits were not highly influenced by nutrition. Calves creep-fed with diet B (CFB) gained in body condition score and had more fat deposits than calves fed diet A (CFA) which in turn surpassed those of the control (NCF) especially from weeks 20 to 24 (Table 7). For instance at 16 and 28 weeks of age, calves fed diet B (CFB group) were similar in BCS with those fed diet A (4.5 ± 0.21 and 4.0 ± 0.21, and 4.8 ± 0.14 and 4.0 ± 0.14, respectively) but significantly exceeded those of the control (NCF) (4.5 ± 0.21 vs 3.5 ± 0.21, and 4.8 ± 0.14 vs 3.6 ± 0.14, respectively). At week 20 and 24, calves fed CFB exceeded those fed CFA which also exceeded those of NCF in BCS (4.5 ± 0.08 vs 4.0 ± 0.08 vs 3.5 ± 0.08, and 4.5 ± 0.11 vs 4.2 ± 0.11 vs 3.8 ± 0.11, for 20 and 24 weeks, respectively). Changes in BCS with age was positive and significantly different between the experimental groups at week 16 only with calves fed CFB gaining a score of 1.50 over 4 weeks (wk 12 to 16) which was comparable to 1.00 for calves fed CFA but significantly higher than 0.50 for calves that were not creep-fed.

Calves fed CFA had equivalent gain in BCS with those of the control at this age. Changes in BCS were low and insignificantly different between treatment groups in subsequent ages. Remarkably, calves belonging to all the groups had no change in BCS at week 20 but had reduced BCS by the end of the study with reduction in score being smaller (numerically) in calves fed diet B.

Table 7: Body condition score (1 to 5 point scale) of crossbred bull calves fed or denied creep feeding

Body condition scoore	NCF	CFA	CFB	SEM
BCS_{12}	3.0	3.0	3.0	0.10
BCS_{16}	3.5^{a}	4.0^{ab}	4.5^{b}	0.21
BCS_{20}	3.5^{a}	4.0^{b}	4.5^{c}	0.08
BCS_{24}	3.8^{a}	4.2^{b}	4.5^{c}	0.11
BCS_{28}	3.6^{a}	4.0^{ab}	4.8^{b}	0.14
Changes in body condition score (BCS)				
$CBCS_{16}$	0.50^{a}	1.00^{ab}	1.50^{b}	0.17
$CBCS_{20}$	0.00	0.00	0.00	0.18
$CBCS_{24}$	0.30	0.20	0.00	0.16
$DBCS_{28}$	-0.20	-0.20	-0.03	0.18

NCF: no creep feeding, CFA: creep fed with diet A, CFB: creep fed with diet B, BCS_i: body condition score at the i^{th} age in weeks, $CBCS_i$: change in body condition score at the i^{th} age in weeks, SEM: standard error of mean.

Table 8: Agewise correlation matrix for growth traits of beef bull calves fed or denied creep feed

	BWT_{12}	**BWT_{16}**	**BWT_{20}**	**BWT_{24}**	**BWT_{28}**
BWT_{12}	-				
BWT_{16}	0.16	-			
BWT_{20}	-0.36	-0.16	-		
BWT_{24}	-0.33	0.01	0.93^{**}	-	
BWT_{28}	-0.33	-0.04	0.89^{**}	0.94^{**}	-
	BLT_{12}	**BLT_{16}**	**BLT_{20}**	**BLT_{24}**	**BLT_{28}**
BLT_{12}	-				
BLT_{16}	0.74^{*}	-			
BLT_{20}	-0.21	0.16	-		
BLT_{24}	0.67^{*}	0.27	-0.02	-	
BLT_{28}	-0.27	0.20	0.31	-0.47	-
	HTW_{12}	**HTW_{16}**	**HTW_{20}**	**HTW_{24}**	**HTW_{28}**
HTW_{12}	-				
HTW_{16}	0.39	-			
HTW_{20}	0.26	0.92^{**}	-		
HTW_{24}	0.17	0.54	0.45	-	
HTW_{28}	-0.25	0.29	0.54	-0.09	-
	HGT_{12}	**HGT_{16}**	**HGT_{20}**	**HGT_{24}**	**HGT_{28}**
HGT_{12}	-				
HGT_{16}	0.65	-			
HGT_{20}	-0.12	0.53	-		
HGT_{24}	-0.06	0.41	0.90	-	
HGT_{28}	0.13	0.57	0.72	0.45	-
	HDC_{12}	**HDC_{16}**	**HDC_{20}**	**HDC_{24}**	**HDC_{28}**
HDC_{12}	-				
HDC_{16}	0.42	-			
HDC_{20}	0.63	0.61	-		
HDC_{24}	-0.05	0.33	-0.18	-	
HDC_{28}	0.39	0.73^{*}	0.68^{*}	0.15	-
	BCS_{12}	**BCS_{16}**	**BCS_{20}**	**BCS_{24}**	**BCS_{28}**
BCS_{12}	-				
BCS_{16}	0.34	-			
BCS_{20}	0.15	0.87^{**}	-		
BCS_{24}	-0.14	0.59	0.79^{**}	-	
BCS_{28}	0.08	0.90^{**}	0.88^{**}	0.75^{*}	-

BWT_i, BLT_i, HTW_i, HGT_i, HDC_i, BCS_i: body weight, body length, height at withers, heart girth, head circumference, and body condition score at the i^{th} age in weeks; *: $P<0.05$; **: $P<0.01$.

The higher BCS obtained in calves subjected to creep supplementation relate to the improved nutrition and feed utilization usually associated with creep feeding of calves (Shike et al., 2007; Parish and Rhinehart, 2009; Vinoles et al., 2013). The rise in BCS to 4.8 in calves fed CFB by the end of the experiment meant that these animals had higher fat deposition than those fed CFA as well as the control group in decreasing order. This is in agreement with Anderson (2008) that creep feeding improves marbling in calves. Differences in marbling associated

Table 9: Agewise correlation matrix between growth parameters in calves fed or denied creep feed

	BWT_{12}	**BLT_{12}**	**HTW_{12}**	**HGT_{12}**	**HDC_{12}**	**BCS_{12}**
BWT_{12}	-					
BLT_{12}	0.25	-				
HTW_{12}	0.55	0.57	-			
HGT_{12}	0.34	0.96^{**}	0.53	-		
HDC_{12}	0.55	0.19	0.24	0.16	-	
BCS_{12}	-0.15	-0.46	-0.37	-0.48	-0.28	-
	BWT_{16}	**BLT_{16}**	**HTW_{16}**	**HGT_{16}**	**HDC_{16}**	**BCS_{16}**
BWT_{16}	-					
BLT_{16}	0.34	-				
HTW_{16}	0.72^{*}	0.00	-			
HGT_{16}	0.19	0.60	0.58	-		
HDC_{16}	0.20	0.52	0.55	0.59	-	
BCS_{16}	-0.19	-0.45	-0.51	-0.41	0.09	
	BWT_{20}	**BLT_{20}**	**HTW_{20}**	**HGT_{20}**	**HDC_{20}**	**BCS_{20}**
BWT_{20}	-					
BLT_{20}	0.73^{*}	-				
HTW_{20}	-0.45	0.08	-			
HGT_{20}	0.11	0.46	0.28	-		
HDC_{20}	0.32	0.74^{*}	0.58	0.59	-	
BCS_{20}	0.81^{**}	0.46	-0.74^{*}	-0.06	-0.08	-
	BWT_{24}	**BLT_{24}**	**HTW_{24}**	**HGT_{24}**	**HDC_{24}**	**BCS_{24}**
BWT_{24}	-					
BLT_{24}	-0.02	-				
HTW_{24}	-0.50	0.26	-			
HGT_{24}	-0.09	-0.22	-0.22	-		
HDC_{24}	0.24	0.34	0.09	0.39		
BCS_{24}	0.93^{**}	0.24	-0.52	-0.25	0.16	-
	BWT_{28}	**BLT_{28}**	**HTW_{28}**	**HGT_{28}**	**HDC_{28}**	**BCS_{28}**
BWT_{28}	-					
BLT_{28}	0.20	-				
HTW_{28}	-0.43	0.55	-			
HGT_{28}	0.06	0.05	0.43	-		
HDC_{28}	0.20	0.52	0.35	0.53	-	
BCS_{28}	0.93^{**}	0.27	-0.36	-0.10	0.11	-

BWT_i, BLT_i, HTW_i, HGT_i, HDC_i, BCS_i: body weight, body length, height at withers, heart girth, head circumference, and body condition score at the i^{th} age in weeks; *: P<0.05; **: P<0.01.

with creep feeding and nutrient composition of creep feeds have been reported in other studies (Anderson, 2008; Parish and Rhinehart, 2009). The higher BCS of creep fed calves also correspond to the observed significantly higher growth rate in these animals (Table 2). On the 5 point scale employed for BCS in the present study, calves in the control appeared to be in optimal body condition compared to those subjected to creep feeding (Agra Point International, 2003). For heifer and steer calves proposed for breeding (replacement calves), the maintenance of this level of body condition from weaning to breeding age would be critical to avoid the adverse effect of creep feeding on future reproductive performance of the animals (decreased longevity, fewer calves weaned, and increased fat deposition, etc) (Shike et al*.,* 2007; Parish and Rhinehart, 2009). However, for bull calves destined for the feedlot (fattening operation), maximum growth rate and good marbling would be necessary to ensure maintenance of top body condition throughout the fattening period, minimum period in the feedlot, highest weight gain, carcass yield and good marbling at finish (Parish and Rhinehart, 2009). Parish and Rhinehart (2009) stated that finishing performance of creep fed calves is better than non creep fed animals. Obviously, animals entering the feedlot at top optimal performance would perform better than optimal and suboptimal subjects. The reduction in BCS by the 28^{th} week of age (end of experiment) is probably due to a tendency of the animals to limit their nutrient intake in response to their physiological and body needs. The phenotypic correlation between measures of the different growth traits are presented in Table 8. The Table shows very weak phenotypic correlation between measures of body weight (BWT_is),body length (BLT_is), height at withers (HTW_is), heart girth (HGT_is) , and head circumference (HDC_is) while body condition scoreat the various age periods (BCS_is) were more strongly associated with each other.

Among the measures of BWT, BWT_{20} was highly significantly and positively correlated with BWT_{24} and

BWT_{28}, respectively (r = 0.93, and 0.89, respectively, P<0.01) while BWT_{24} was highly significantly correlated with BWT_{28} (r = 0.94, P<0.01). Other correlation coefficients were either positive or negative and non significant. For body length (BLT), significant association was observed between BLT_{12} and BLT_{16} and BLT_{24} only (r = 0.74, and 0.67, respectively, P<0.05) while for HTW, significant correlation was observed between HTW_{16} and HTW_{20} only (r = 0.92, P<0.01). Similar results as the foregoing were observed for heart girth (HGT) and head circumference (HDC). For HGT, significantly positive correlation was observed between measures at week 20 and 24, and 20 and 28 (r = 0.90, P<0.01, and r = 0.72, P<0.05, respectively) whereas for HDC, significant correlations occurred between measures at wk 16 and 28 (r = 0.73, P<0.05) and wk 20 and 28 (r = 0.68, P<0.05). Body condition score (BCS) at wk 12 (BCS_{12}) was not significantly related to those of subsequent age periods whereas the score at wk 16 was positively and significantly related to those of wk 20 and 28,respectively (r = 0.87, and 0.90, P<0.01, respectively). Also, BCS_{20} was significantly associated with BCS_{24} and BCS_{28}, respectively (r = 0.79, and 0.88, P<0.01, respectively) while $BCS_{24}$was significantly related to BCS_{28} (r = 0.75, P<0.05).The weak correlation between age wise measures of body weight, as well as other linear body parameters in the present study was at variance with other studies (Ozkaya and Bozkurt, 2008; Ozkaya and Bozkurt, 2009; Assan, 2013). These studies reported strong correlation or association between measures of body weight as well as other linear body parameters at different age periods. The weak correlations observed may relate to the small sample size in the present study. This submission is informed by the observation that correlation values of up to 0.65 were not significant at the 95% confidence limit. This indicates low sensitivity which could result from small sample size. The correlation matrix for the different growth parameters at the different age periods also showed weak association between parameters (Table 9).None of the morphometric traits measured at wk 12 associated strongly with BWT_{12}. Significant correlations were observed between BLT_{12} and HGT_{12} (r = 0.96, P<0.01), HTW and BWT at wk 16 (r = 0.72, P<0.05), BWT and BLT, BWT and BCS, BLT and HDC, and HTW and BCS at wk 20 (r = 0.73, 0.81, 0.74, and -0.74, P<0.05, respectively). At 24 and 28 weeks of age, only BWT and BCS were strongly related (r = 0.93, and 0.93, respectively, P<0.01). The significant and positive correlation between BWT and HTW, BLT and HGT, BLT and BWT, BWT and BCS, and BLT and HDC are in agreement with previous studies (Ozkaya and Bozkurt, 2008; Ozkaya and Bozkurt, 2009; Assan, 2013). Ozkaya and Bozkurt (2008, 2009) reported moderate to high (r= 0.43 to 0.95) correlation coefficient between body weight and body length, wither height, hip height, hip width, chest depth, chest girth, and body area. In a similar study, Gunawan and Jakaria (2011) reported correlation coefficients of 0.33 to 0.85 between weaning weight and height at withers, body length, and heart girth in Bali cattle and a range of 0.78 to 0.87 between the above traits and yearling weight. Assan (2013) stated that the assessment of body condition score has proven superior to linear measurements as predictor of carcass energy and fat reserves and that BCS and BWT are quadratically related. Milla et al. (2012) stated that at any body condition score, body weight loss is linear. Alphonsus et al. (2010) stated that linear conformation traits, body weight, body condition score and milk yield were linearly related in Friesian x Bunaji cows. Mayo et al. (2002) had reported reductions (negative changes) in BCS associated with losses in body weight and increases (positive changes) in BCS following increases (gains) in body weight. Thus body weight and body condition score could be manipulated to modulate each other (Lalman et al., 1997; Assan, 2013).

CONCLUSION

Creep feeding influenced growth rate, and body condition score of creep fed calves but not most of the linear body parameters. Creep feeding led to higher body weight, overall body weight gain, and increases in body condition score in the creep fed calves compared to non supplemented control group. Calves fed ration containing groundnut cake performed better in BWT and BCS than those fed ration containing soyabean meal. Significant and positive correlation existed between BWT and HTW, BLT and HGT, BLT and BWT, BWT and BCS, and BLT and HDC while HTW was negatively associated with BCS.

ACKNOWLEDGEMENT

The authors are grateful to Prof. F.O. Ahamefule - former Dean of College of Animal Science and Animal Production Michael Okpara University of Agriculture, Umudike for granting approval for use of the college farm facilities for the conduct of the study. We appreciate the commitment and diligence of the Chief Technical Officer-Mr. S. N. Okereke in supervising the experimental animals and data collection.

REFERENCES

Agra Point International (2003). Body condition scoring.Sean firth Ruminants.Fact sheet.

Alphonsus CGN, Akpan OO, Oni PI, Rekwot PP, Barje SM, Yashim (2010). Relationship of linear conformation traits with body weight, body condition score and milk yield in Friesian x Bunaji cows. 38 (1): 97-100.

Anderson BB, (2008). Early high-starch diet critical to carcass quality.Angus Journal pp. 270.

Arthington DJ, Spears JW, Miler DC, (2008). The effect of early weaning on feedlot performance and measures of stress in beef calves. J. Anim. Sci. 83: 933-939.

Assan N, (2013). Bioprediction of body weight and carcass parameters from morphometeric measurements in livestock and poultry. Scientific Journal of Review 2 (6): 140-150.

Blanco M, CasasusI, Palacio J, (2009). Effect of age at weaning on the physiological stress response and temperature of two beef cattle breeds. Animal 3: 108-117.

Cole NA, (1996). Review of bovine respiratory disease: nutrition and disease interactions. Conservation and Production Research Laboratory.Agricultural Research Division U. S. Department of Agriculture, Bushland, Texas.

Ensminger ME, (1991).Animal Science Digest.First Edition.Interstate Publishers. Pp. 78-90.

Entiquez DH, Ungarfeld R, Quintans G, Guidoni AL, Hotzel MU,(2010). The effects of alternative weaning methods on behavior in beef calves.Livst. Sci. 128: 20-27.

Eriquuez D, Hotzel MJ, Ungerfeld R (2011). Minimizing the stress of weaning of beef calves: a review. Acta Vet. Scand. 53: 28.

Gunawan A, and Jakaria J, (2011).Application of linear body measurements for predicting weaning and yearling weight of Bali cattle. Animal Production 12 (3): 163-168.

Lalman DL, Keisier DH, Williams JE, Scholljegerdes EJ, Mallet DM (1997). Influence of post partum weight and body condition change on duration of oestrus by undernourished suckled beef heifers. J. Anim. Sci. 75: 2003-2008.

Lardy GP, AdamsDC, Klopfenstein TJ, Clark RT and Emerson J (2001). Escape protein and weaning effects in calves grazing meadow regrowth. Journal of Range Management 54: 233-238.

Lawton S, (2013) Creep feeding beef calves. Bulletin 1315 of the University of Georgia Cooperative Extension.

Lynch EM, McGeeM, Doyle S and Earley B (2012). Effect of pre-weaning concentrate supplementation on peripheral distribution of leukocytes, functional activity of neutrophils, acute phase protein and behavioural responses of abruptly weaned and housed beef caives. BMC Veterinary Research .downloaded from 8://http://www.biomedcentral.com/174-6148/8/1.

Mayo SJ, Lalman DL, Selk GE, Wettermann RP, and BuchananDS, (2002).Effect of level of cow winter nutrition and calf creep-feeding on fall calving system productivity.Animal Science Research Reports.Oklahoma Agricultural Experimental Station.

Milla AP, Mahagoub MMM, Buusharal (2012). Estimation of live body weight from hearth birth, body length and body condition score in Nilotic cattle-Southern Sudan. J. Anim. Sci. Adv. 2 (5): 453-457.

Myers SE, Faulkner DB, Ireland FA, Parrett DF (1999). Comparison of three weaning ages on cow-calf performance and steer carcass traits. J. Anim. Sci. 77: 323-329.

Otoikhian CSO, Otoikhian AM, Akporhuarho OP and Isidahomen C, (2008). Correlation of body weight and somebody measurement parameters in Ouda sheep under extensive management system. African Journal of General Agriculture 4 (3): 129-133.

Ozkaya S and Boskurt Y, (2009). The accuracy of prediction of body weight from body measurements in beef cattle. ArchivTierzucht 52 (4): 371-377.

Ozkaya, S. and Bzkurt Y (2008). The relationship of parameters of body measures and body weight by using digital image analysis in pre-slaughter cattle. Arch. Tierz., Dummerstorf 51 (2): 120-128.

Parish J and Rhinehart J (2009). Creep feeding beef calves. Publication 2524.The Mississipi State University Extension Service.

Price EO, Harris JE, Borgwardt RE, Sween ML, Connor JM (2003). Fenceline contact of beef calves with their dams at weaning reduces the negative effects of separation on behavior and growth rate. J. Anim. Sci. 81: 116-121.

Shike DW, Faulkner MJ, Cecava DF, Parrett, and Ireland FA (2007). Effects of weaning age, creep feeding, and type of creep on steer performance, carcass traits, and economics. Journal of Animal Science 23: 325-332.

Sowande D, and Sobola O (2008). Body measurements in West African dwarf sheep as parameters for estimation of live weight. Trop. Anim. Health Prod. 40: 433-439.

Vinoles C, Jaurena M, De Barbieri I, Canno MD and Montossi F (2013). Effects of creep feeding and stocking rate on the productivity of beef cattle grazing grasslands. New Zeland Journal of Agricultural Research 56(4):279-28