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COMPENSATORY GROWTH IN GROWING WEST AFRICAN DWARF KIDS IN THE HUMID ZONE OF NIGERIA.

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ABSTRACT : Compensatory growth response to liberal concerntrate supplement of growing West African Dwarf (WAD) male kids previously reared on poor natural pasture in the dry season was studied. Partial feed conversion efficiency (FCE) and variation in carcass characteristics were also studied. The total experimental period consisted of three phases of 63 (phase 1), 49 (phase 2) and 77 (phase 3) days. There were four groups (A to D) of 10 growing kids each. Group D was the unsupplemented control while the other three groups received high levels of supplement in the third phase after each of them were kept unsupplemented either in both phase 1 and 2 (Group C) or in phase 1 alone (Group B) or in neither of the two phases (Group A). In phase 1, Group A kids gained 1.10kg live weight while kids in the other groups lost 1.48kg. In phases 2 and 3, kids in groups B and C respectively, showed compensatory growth. Live weight differences between groups A, B and C observed in previous phases became non-significant in the last phase. Partial FCE was higher in kids, which showed compensatory growth than in continuously growing kids, particularly when live weight differences between them became non-significant. Carcass evaluation showed highly significant ($P<0.01$) correlation with live weight. The implications of the study showed that under natural grazing conditions, where dry season supplementary feeding is not practicable, growing WAD kids can be maintained on grazing alone and subsequently feed concentrate supplement. This will certainly enable the growing kids to benefit from catch-up growth phenomenon and better partial FCE compared to kids that are allowed to grow continuously under supplementation with added advantage of reducing feed cost.
Keywords: Catch-up growth, Feed Conversion Efficiency, Feed restriction, Carcass composition.

INTRODUCTION

In Nigeria, one of the major problems of ruminant production is the scarcity of forages all year round. The natural rangeland is the most important source of food for ruminants. Livestock have abundance of pasture to take in the first six months of the rainy season during which animals are relatively well fattened. However, in some tropical pastures even in the wet season, high yields are not necessarily matched by high nutritional values. The other six months are always followed by scarcity of forages because of the dry period, resulting in standing hay and low quality feed that eventually culminates in the growth retardation of animals (Babayemi *et al*., 2003; Mako *et al.,* 2001). Goats are actually an exception because they even lose weight in the rainy season especially in the forested zone of Nigeria when continuous rain restricts grazing time (Anya, 2001). The periodic feed shortage results in the weight loss of grazing ruminants and is particularly evident in young animals (Ryan, 1990).

Animals subjected to a period of undernutrition often exhibit very high growth rate during subsequent re-alimentation (McManus *et al.,* 1972; Thornton *et al.,* 1979; Abegaz *et al.,* 1996). This phenomenon is known as compensatory growth. Compensatory (catch-up) growth may be defined as a physiological process whereby an organism accelerates its growth after a period of restricted development usually due to reduced feed intake, in order to reach the weight of animals whose growth was never reduced (Hornick *et al.,* 2000; Dashtizadeh *et al.,* 2008). According to Carstens (1995), compensatory growth is the greater than expected weight gain sometimes seen in animals following an extended period of slow growth or weight loss due to restricted nutrition. This phenomenon has very important implications in countries like Nigeria that depend largely on grazing natural pasture to support animal production coupled with feed restrictions which occur due to seasonal variations in nutrient quality and quantity of available pasture materials (Drew and Reid, 1975; Anya *et al*., 2008). Body composition is dynamic and changes continuously in response to environmental factors (Kabbali *et al*., 1992). Thus, animals may respond differently to re-alimentation when nutritional restriction is removed or eliminated. However, it is not always complete, with some animals demonstrating either partial or no compensation because this catch-up growth is a complex metabolic function and a number of mechanism are involved (O'Donovan, 1984). Extensive studies in cattle and sheep have shown that this variability in the rate of catch-up growth may be influenced by genetic factors, the age of which restriction is imposed, the severity and duration of restriction, the quality of re-alimentation diet and duration of re-feeding (Benschop, 2000; Lawrence and Fowler, 2002). There have been many studies into the phenomenon of compensatory growth in cattle and sheep, which seem to suggest that animals recover quite well after a feed restriction (Read and Tudor, 2004). Restricted animals often compensate within the same period as their unrestricted counterparts and often achieve greater growth rates. There appears to be a critical period in cattle and sheep from birth to three months of age when nutritional restriction will not trigger a compensatory growth (Dastizadeh *et al.,* 2008). Following this period, animals can exhibit catch-up growth until they reach maturity (Ryan, 1990). Compared to cattle and sheep, very few studies have been conducted on goats, particularly the West African Dwarf goats in the humid zone of Nigeria.

In Nigeria, goats are important grazing ruminants and face periodic shortages of feed availability in their natural habitat, which directly affects their body composition. About 34.5 million goats in Nigeria (FAO, 1991) raised mainly on natural pasture and to a limited extent on crop residues. Seasonal fluctuation in quality and quantity as well as the fast growth and rapid lignifications of most forage species are the causes of feed shortage, which is exacerbated by recurring dry periods (Anya, *et al.,* 2008).

This experiment was therefore designed to study compensatory growth and body composition changes resulting from this phenomenon in 7months old weaned male kids of West African Dwarf (WAD) goats maintained unsupplemented on natural pasture during the dry season for various periods, and then fed liberal concentrate supplement to finish them.

MATERIALS AND METHODS

Location

The study was carried out at the sheep and goat unit of the Faculty of Agriculture Teaching and Research Farm, University of Calabar, Calabar; located between $4^0 - 5^0$ and $8^0 - 8.5^0$E along the coastal plains (Humid forest region of Nigeria). The farm receives a mean annual rainfall of about 3,071.7mm, out of which 90% falls in the months of April to October, and has mean maximum and minimum temperatures of and respectively.

Experimental Animals and Treatment

Kids used in this study were of the "Akpabuyo" type of the West African Dwarf breed (Anya, 2001). All kids were vaccinated against PPR using cattle tissue rinderpest vaccine, a small ruminant disease endemic in the humid high rainforest zone. Animals were also dewormed (using thiabenzole) and purged of external parasites using asuntol solution periodically (every 3 months). Fourty weaned male kids with mean live weight of 11.21± 1.16kg were balanced for weight and randomly assigned to 4 treatment groups (A to D). The whole experimental period (1st November, 2009) to (5th May, 2010) was divided into three phases of 63 (phase 1), 49 (phase 2) and 74 days (phase 3). Kids in group A were supplemented throughout the experimental period, those in group B were supplemented in phases 2 and 3 and those in group C were supplemented in phase 3 only. Kids in group D received no supplement throughout the experiment.

Experimental Diet and Management:

The amount of concentrate supplement fed in the first two phases was 150g/head/day while in the third phase was 333g/head/day. The supplement, made up of African yam bean, wheat offal, brewer's dried grains and palm kernel cake was formulated to contain 21.5% CP and 3.05 kcal metabolisable energy (ME) per g of dry matter (DM).

All growing kids were managed as one flock each day of the experiment and grazed from 0830 to 1700hours on poor natural pasture, which had an estimated yield of 6.8t/ha with a DM content of 70% at the beginning of the experiment. Each evening, the growing kids were separated into their respective treatment groups. Kids in each group were properly identified with neck straps.

Carcass Evaluation

Sixteen (16) growing kids, 4 each from the respective groups (A-D) were selected at the end of the experiment for the measurement of carcass and non-carcass cuts, weighed and dressing percentage determined. All sixteen kids selected for this evaluation were fasted (without feed & water) 36 hours prior to slaughter. Shrunk live weights of the kids were then taken just before slaughter.

Statistical Analysis

Analytical procedure for a completely Randomized Design experiment was used to analyze between treatment differences in live weight and weight gain. Significant means were separated using Duncan's Multiple Range Test as outlined by Obi (1991). Relationship between weight measurements of the various carcass cuts and live weight was determined by regression procedures (Steel and Torrie, 1980).

Partial feed conversion efficiency (FCE) of supplement growing kids was calculated from the total amount of supplement offered and live weight gain obtained above those of unsupplemented kids.

RESULTS

Four kids (two from group D and one each from Groups B and C) died. Post-mortem examination by a team of vertinarians revealed that they all died of Bronchial-pneumonia before the end of the experiment and were excluded from the analysis.

Table 1 shows that in phase 1 kids in Group A gained an average of 1.10kg live weight while kids in groups B, C and D lost an average of 1.45kg. Upon supplementation in phase 2, kids in Group B gained significantly ($P<0.05$) more weight (2.85kg) than kids in Group A (1.65kg) which received supplementation from the beginning (Group A, 1.65kg) or unsupplemented kids in Groups C (0.40kg) and D (0.45kg). Group C kids gained significantly ($P<0.05$) more weight (8.15kg) than all the kids in the remaining groups (6.57, 6.82 and 2.70kg for Group A, B and C respectively) in the third phase. However, the difference in gain between Groups A, B and C was found to be non-significant after the first 55days of phase 3.

Table 1: Live weight changes and daily weight gains during each phase and the whole experimental period (Mean ± SEM)

	Treatment Group				
	Overall	A	B	C	D
No of kids	36	10	9	9	8
Initial weight (kg)	11.21±0.51	11.20±1.31[a]	11.23±0.95[a]	11.21±1.04[a]	11.18±0.90[a]
WEP1 (kg)	10.18±0.48	12.85±1.10[a]	8.83±0.91[b]	9.51±0.80[b]	9.28±0.71[b]
WEP2 (kg)	12.09±0.52	15.15±1.02[a]	12.73±0.96[ab]	10.31±0.75[bc]	1.18±0.51[c]
WEP3 (kg)	20.22±0.72	22.85±1.01[a]	21.83±1.08[a]	21.11±0.75[a]	15.08±0.75[b]
GP-A (kg)	-0.85±0.29	1.10±0.43[a]	-1.65±0.40[a]	-1.30±0.40[b]	-1.50±0.31[b]
GP-B (kg)	1.20±0.21	1.65±0.20[b]	2.85±0.25[b]	0.40±0.15[c]	0.45±0.18[c]
GP-C (kg)	6.23±0.35	6.57±0.45[b]	6.82±0.65[b]	8.15±0.55[a]	2.70±0.24[c]
Total gain (kg)	9.01±0.55	11.65±0.55[a]	10.60±0.50[b]	9.90±0.50[b]	3.90±0.21[c]
First 55 days of P3 (kg)	5.10±0.35	5.12±0.48[b]	5.50±0.71[b]	6.85±0.50[a]	2.25±0.25[c]
Last 19 days of P3 (kg)	1.13±0.12	1.45±0.18[a]	1.30±0.24[a]	1.30±0.25[a]	0.45±0.20[b]

WEP1, 2, 3 = Weight at the end of phases 1, 2, 3
GP-A, B, C = Weight gain in phases 1, 2, 3
Means within the same row with different superscripts are significantly different ($P<0.05$).

Table 2 shows the results of the response in gain due to supplementation and partial FCE of kids. For the entire experimental period, kids in Group C had a better partial FCE (5.16) than kids in group A (5.76) and B (5.64). The observed superiority in conversion efficiency, however declined as live weight differences reached non-significant levels (Last 19 days of phase 3).
Table 3 shows results of mean weight and carcass evaluation of the respective treatment groups. All weights have shown a tendency to increase with increase in live weight. Polled regression of shrunk live and carcass weights, dressing percentage and weight of other parts on live weight was found to be highly significant ($P<0.01$). Fat deposition as measured by caul and kidney fat (weighed together) and tail weight were highly correlated with live weight.

Table 3: Carcass evaluation values, dressing percentages (%) and correlations with live weight of growing kids.

Parameters	Overall	A	B	C	D	r^2
Live weight (kg)	20.33	22.85	21.50	21.30	15.75	
Slaughter weight (kg)	18.52	20.95	19.90	19.10	14.15	0.97**
Carcass weight (kg)	8.74	10.88	9.48	9.12	5.47	0.94**
Dressing %	42.99	47.60	44.10	42.82	34.73	0.66**
Tail weight (kg)	0.63	0.75	0.68	0.60	0.50	0.69**
Skin weight (kg)	1.93	2.20	2.10	1.90	1.50	0.94**
Viscera full (kg)	4.33	4.80	4.60	4.10	3.80	0.88**
Legs (kg)	0.48	0.52	0.48	0.50	0.41	0.80**
Internalorgans[1] (kg)	1.18	1.27	1.18	1.25	1.01	0.92**
Caul + kidney fat (kg)	0.063	0.08	0.07	0.06	0.04	0.84**
Head (kg)	1.31	1.55	1.35	1.25	1.10	0.81**

1 =Liver, Lung/trachea, heart, kidney (fats free) and spleen weighed together.
r^2 = correlation of carcass values with live weight.
** = Significant at $P<0.01$ level.

DISCUSSION

Kids given no supplementary feed and grazed on natural pasture in the dry season lost weight while the supplemented kids gained weight. This confirms the fact that in humid forest zone in Nigeria, natural pasture alone cannot maintain weight or support growth of kids in the dry season. This observation in this study agrees with the report of Abegaz *et al*. (1996) and Galal *et al.* (1981) working with Horro lambs, where lambs even lost weight in the dry season when kept on cultivated pasture.

Upon supplementation, previously unsupplemented kids, which had lost weight, gained more than the continuously supplemented kids. Similar compensatory responses have been reported for Sudanese female goats (Yagoub and Babiker, 2009), Iranian native goats (Dashtizadeh *et al.,* 2008), growing lambs (Abegaz *et al.,* 1996; Kabbali *et al.,* 1992), Yankassa sheep (Lakpini *et al.,*1982) and Black head Persian/Massai lambs (Massae and Mtenga, 1992).

Upon supplementary feeding, the partial FCE of previously unsupplemented kids was higher than the partial FCE of kids supplemented continuously. Dashtizadeh *et al.* (2008) had reported similar improvements with Iranian native goats while the reports of Turgeon *et al*. (1986); Abdalla *et al*. (1988) and that of Yagoub and Babiker (2009) with Sudanese female goats corroborates the findings in this study. Thornton *et al.* (1979), Massae and Mtenga (1992), Kabbali *et al.* (1992) and Abegaz *et al.* (1996) in their studies also reported similar findings of improvements in FCE in sheep. In the same vein, Ryan (1990) reported that increased duration of feed restriction is likely to increase the rate of growth after re-alimentation, which seeks to explain the findings of higher partial FCE of unsupplemented kids over kids supplemented continuously in this study. However, on the contrary, Yagoub and Babiker (2009) reported lower weight gains with compensated female goats while Toukourou and Peters (1999) found no difference in weight gains and FCE among the compensated and control goat groups in their studies. In addition, Graham and Searle (1975) found no difference between FCE of re-alimented and continuously fed sheep.

Table 2: Gain response to supplementation, quantity of supplementary feed offered and partial feed conversion efficiency (PFCE).

	Treatment Group		
	A	B	C
Mean gain over unsupplemented			
Phase 1[a]	3.25	1.42	-
Phase 2[b]	1.35	2.92	-
Phase 3[c]	3.70	4.04	4.70
Total	7.03	5.46	4.70
First 55 days phase 3	2.50	3.25	4.10
Last 19 days phase 3	0.95	0.82	0.90
Total supplementary feed given:			
Phase 1	9.59	-	-
Phase 2	6.58	6.58	-
Phase 3	24.24	24.24	24.24
Total	40.41	30.82	24.24
First 55 days of phase 3	17.63	17.63	17.63
Last 19 days of phase 3	6.10	6.10	6.40
Partial FCE			
Phase 1	2.95	-	-
Phase 2	4.87	2.35	-
Phase 3	6.55	6.00	5.16
Total	5.75	5.64	5.16
First 55 days of phase 3	7.05	5.42	4.30
Last 19 days of phase 3	6.42	7.43	6.77

a = gain over mean of Groups B, C and D
b = gain over mean of Groups C and D
c = gain over mean of Group D

This discrepancy might be related to age, breed/type of animals, length of recovery (compensated) period, severity and duration of restriction period and the type of re-alimentation diet as animals are known to respond differently based on the diverse mechanisms implicated in the compensatory growth phenomenon (McMannus *et al.*1972; Drew and Read, 1975; Mora *et al.,* 1996; Ryan, 1990; Benschop, 2000; Hornick *et al.,* 2000; Sanz-sampelayo *et al.,* 2003; Joemat *et al.,* 2004 and Yagoub and Babiker, 2009). These may explain the varied discrepancies reported in the literature.
Carcass evaluation and dressing percentage values showed a tendency to increase with increase in weight. In addition, values of correlation coefficients pooled over all the treatments (A – D) were very high. The strong correlation between the various carcass cuts and live weight suggest that within the growth stage of kids in this study. Similar live weights achieved either by compensatory or continuous growth can yield carcasses with similar composition and proportion of parts. In all the carcass parameters investigated, the values for supplemented (or re-alimented) kids were higher than those for unsupplemented. Feeding level affects the carcass composition and proportion of cuts (Butler-Hogg, 1984; Murphy and Loerch, 1994; Murphy *et al.,* 1994; Mora *et al*., 1996). When feeding is restricted, growth rate is reduced because of coordinated decrease in tissue turnover, the reverse suffices.
In general, however, early maturing parts (head, feet and visceral organs) have higher priority for use of available nutrients during compensatory growth. Dashtizadeh *et al*. (2008) reported that increase in the size of gastro intestinal/visceral organs and the amount of gut content may account for all or portion of the weight gain during compensatory growth, which perfectly agrees with the findings of this study (Table 3). Though it does not appear that changes in digestibility is a key factor involved in compensatory growth (Comby 2000; Weekes, 2000), but reports have it that the gut and visceral organs are the first to be replenished with nutrients during re-alimentation (Kabbali *et al.,* 1992), hence the findings in this study.

Implications and Conclusion:

In most goat production systems in Nigeria, kids survive on their body reserves during periods of feed shortage (dry season) and replenish them when adequate nutrition is restored (rainy season). Consequence of such pattern of growth on feed efficiency and body composition are important in defining feeding strategies for periods of shortage or undernutrition. A key point to emphasize here is the timing of this compensatory or catch-up growth as age and many other factors interact to influence this phenomenon. Growing WAD kids grazing natural pasture during the dry season and given no supplementary feed were found to lose weight. Upon subsequent supplementary feeding, the kids showed compensatory growth and caught up with live weights of continuously supplemented kids. Effect of compensatory growth on carcass characteristics was not too obvious, but it improved partial FCE. Results of this study suggest that in the dry season, unsupplemented kids grazing natural pasture can tolerate weight losses of at least 10% with no long-lasting effect and upon subsequent supplementation (re-alimentation); they can experience compensatory gain with high FCE.

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