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Feed Restriction and Realimentation on Performance and Carcass Characteristics of Growing Rabbits in a Humid Environment

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ABSTRACT

The effects of feed restriction for three weeks followed by a four-week realimentation on performance and carcass characteristics were investigated in growing rabbits in a derived savannah vegetation zone of South West Nigeria. Thirty (30) growing rabbits of mixed breeds and sexes with an average weight range of 750 – 800g were randomly distributed into five restriction regimes which served as the study treatments. The rabbits were divided into five groups of six rabbits each. Each treatment was replicated three times with two rabbits per replicate. The experiment was carried out using the completely randomized design (CRD). The rabbits in Treatment 1 (T_1) (control) were fed *ad libitum*, whereas those in Treatment 2 (T_2) and Treatment 3 (T_3) were restricted to 80% and 60% of *ad libitum* respectively throughout the 7-week study period. Meanwhile, the rabbits in Treatment 4 (T_4) were restricted to 80% of *ad libitum* for three weeks and later fed *ad libitum* for the remaining three weeks, whereas those in Treatment 5 (T_5) were restricted to 60% of *ad libitum* for three weeks and later fed *ad libitum* for the remaining four weeks. The trial lasted for 7 weeks after which the rabbits were starved overnight and slaughtered. Weight gain over the entire period, average daily gain and average daily feed intake over the 49 days of experimental period were significantly ($P<0.05$) influenced by the feeding regime employed. The least average daily weight gain over the entire period of the experiment was observed on the rabbits subjected to 60% of *ad libitum* feeding throughout the experimental duration. The rabbits in Treatment 4 (which were restricted to 80% of *ad libitum* feeding for 3 weeks followed by 4 weeks of *ad libitum* feeding showed a consistent similarity in performance with the rabbits on *ad libitum* feeding (Control). Feed restriction regimes significantly influenced ($P<0.05$) dressed weight and dressing out

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percentage (DOP); however, there were no effects (P>0.05) on the forelimb, loin, hind limb and thoracic cage weights of the rabbit carcasses. In terms of overall performance, the rabbits in Treatment 4, however, required less feed to gain a unit weight as compared to the rabbits in other treatments. Based on the findings of this study, it was concluded that feed restriction did not significantly influence carcass yield and relative organs investigated. It is recommended that growing rabbits can be subjected to a three-week feed restriction of not more than 20% provided at least four weeks of *ad libitum* feeding is allowed for compensatory growth.

Keywords: Feed restriction, realimentation, rabbits, performance, and carcass characteristics

INTRODUCTION

Interest in rabbit production has been on the increase in recent years. Rabbit occupies a unique niche in that it is a mini livestock that is easy to manage, highly prolific and has a short generation interval. The cost of feeding rabbits is however very high, a condition that also prevails for other Nigerian livestock species (Adeyemi *et al*., 2008). Currently, there has been an increased interest in studying feed restriction in rabbits as a means of reducing the cost of production. Growing rabbits usually have unlimited access to the feed and eat *ad libitum.* In a restricted feeding system, either the access of the animals to the feed is limited, or a fixed amount of feed is given. There are two methods for restricting feed intake, namely, qualitative and quantitative. In a qualitative feed restriction, the total amount of feed distributed to each animal is the same, but the feed composition can be changed, such as by increasing the fibre level and reducing the digestible energy content (Feugier, 2002). Quantitative feed restriction can be achieved by limiting the time for access to the feeder or by reducing the quantity of feed distributed (Feugier, 2002; Szendrö *et al*., 2000).

Restricted rabbits are reported to have improved feed efficiency (Maertens and Peeters, 1988; Perrier and Ouhayoun, 1996; Tůmová *et al*., 2002, 2003). Improved digestibility of nutrients at restricted feeding period was found in rabbits by Ledin (1984a, b). Feed restriction also reduces carcass fat deposition. Limiting feed intake depresses growth during the period of restriction, but reduced growth can be later compensated by realimentation. This phenomenon of accelerated growth following a period of feed restriction is termed "compensatory growth" (Tumova *et al*., 2002).

Most of the restriction studies carried out in rabbits were conducted in temperate regions of the world, thus there is a need to investigate the situation in a tropical climate. The present study was carried out to investigate the effect of quantitative restriction with or without *ad libitum* feeding after a restriction period on the growth and carcass indices under a tropical environment.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the rabbitry unit of the Teaching and Research Farm, Directorate (TREFAD), Federal University of Agriculture, Abeokuta, Nigeria. The location lies within the rainforest vegetation zone of South West Nigeria with a mean annual rainfall of 1100 mm, a temperature of 34.7^{0}C, and a relative humidity of 82%. It is located in the region 70 m above sea level, with latitude 7^{0}5' to 7^{0}8'N and longitude 3^{0}11.2'E (Federal University of Agriculture, Abeokuta, Meteorological Station).

Rabbit Management and Housing

Thirty (30) growing rabbits of mixed breeds (Chinchilla x Dutch x California White) and sexes (20 males and 10 females) with an average weight of 750-800 g were selected for this experiment from a larger pool of 80 rabbits in the weight classification of 700 to 900 g in such a manner to minimize variations in initial weights between replicate pens. The rabbits were housed two per cells, in which there were three groups made up of two groups of two males and one group of two females per treatment in single tier hutches that had been washed and properly disinfected. The hutches raised 90 cm above the floor were housed in an open sided house that allowed for flow through ventilation. The hutches made of wood and wire mesh were divided into pens with a dimension of 120 x 50 x 45 cm each. Two flat bottom 20 cm wide earthen pots with inner lips to prevent wastage were placed in each pen, one serving as a feeder while the other one as a drinker. The rabbits were treated for endo and ectoparasites using Ivomec® at 1ml/50 kg live weight.

Experimental Design

The experiment was carried out as a completely randomized design with five treatments. Each treatment group was replicated three times with two rabbits housed in the same cell serving as a replicate. The treatments were as follows:

T1: *ad libitum* feeding

T2: 80% of *ad libitum* feeding for the entire feeding trial

T3: 60% of *ad libitum* feeding for the entire feeding trial

T4: 80% of *ad libitum* (0-3 weeks) and *ad libitum* for the remaining four (3-7) weeks

T5: 60% of *ad libitum* (0-3 weeks) and *ad libitum* for the remaining four (3-7) weeks

Ad libitum feed intake of rabbits of the same weight class had been previously determined in a preliminary study. Briefly, 20 rabbits were allowed to acclimate for 3 days on *ad libitum* feeding and allowed free access to water at all times. After the acclimation period, the rabbits were offered feed *ad libitum* for 21 days during which *ad libitum* feed intake for each week was established. It is this established weekly *ad libitum* feed intake that was utilized in the present study. The composition of the diet is shown in Table 1. The ingredient

composition (%) of the diet was on *as-fed* basis. The diet was based on feed composition used for growing rabbits on the Federal University of Agriculture Abeokuta, Teaching and Research Farm, which was developed in line with the recommendations of Hall (2010) and Merck (2011). The major ingredients (i.e. maize, groundnut cake and soy bean meal) were milled through a screen mesh size of 3.5 mm in a hammer mill. Other ingredients were already in milled forms at the point of purchase. The various ingredients were individually weighed out in their milled form into a rotary feed mixer and mixed to get the experimental diet. The experimental feed was mixed in the research feed mill. The feed was fed in mash form.

DATA COLLECTION AND ANALYSIS

Feed Intake

The feed intake per replicate cage was determined by collecting the left-over feed from the feeders each morning at 08:00 hrs before feeding. The daily collection of the left-over feed from each replicate was stored in marked nylon bags and kept in airtight plastic containers. These were bulked together at the end of each week, weighed and subtracted from the addition of daily feed supplied to get the feed intake per replicate cage. The value obtained was divided by the number of rabbits in the pen (2) to get the feed consumption per rabbit per week. The daily intake was derived by dividing the weekly intake by 7. Feed and water were supplied on a daily basis after removing the left-over feed each morning.

$$\textit{Feed intake (g)} = \frac{\textit{Feed supplied - Feed left over}}{\textit{No of rabbit in the replicate}}$$

Body Weight and Weight Gain

The rabbits in each replicate cage were weighed together at the beginning of the trial and weekly thereafter. The gain for each week was obtained by the value difference. The value obtained was divided by the number of rabbits in each replicate to get the weight gain per rabbit per week. From this, the weight gain per day was calculated.

TABLE 1
Composition of experimental diet (% as-fed)

Ingredient	**(%)**
Maize	47.50
Groundnut cake	10.00
Soybean meal	8.00
Wheat offal	31.00
Bone meal	3.00
Salt	0.25
Vitamin/mineral premix*	0.25
Total	**100.00**
Determined Analysis (% DM)	
Dry matter	89.45
Protein	18.74
Ether extract	4.58
Crude Fibre	15.68
NDF	34.29
ADF	20.54
ADL	3.31
Ash	4.25
Metabolisable Energy^{+} (KJ /Kg)	10.93

*contains *Vit. A 4000000IU; Vit. D. 800000IU; Vit. E 40000mg; Vit. K_3 800mg; Vit. B_1 1000mg; Vit. B_2 6000mg; Vit.B_6 5000mg; Vit.B_{12} 25mg; Niacin 6000mg; Pantothenic acid 20000mg; Folic acid 200mg; Biotin 8mg; Manganese 300000mg; Iron 80000mg; Zinc 20000mg; Cobalt 80mg; Iodine 400mg; Selenium 40mg; Choline 800000mg*
$^{+}$=Calculated

$$\text{Average weight gain (g/rabbit)} = \frac{\text{Final weight - Initial weight}}{\text{No of rabbit in the replicate}}$$

$$\text{Average daily weight gain}\left(\frac{g}{\text{rabbit}}/\text{day}\right) = \frac{\text{Final weight} - \text{initial weight}}{\text{No of rabbit in the replicate x No of days on trial}}$$

Feed Conversion Ratio (FCR) was determined as follows:

$$\text{Feed conversion ratio} = \frac{\text{Average Feed Intake}(g/\text{rabbit})}{\text{Average Daily Weight Gain}(g/\text{rabbit})}$$

Carcass Characteristics

Since there were two rabbits per replicate cage, one rabbit was taken from each replicate. This constituted 50% of the replicate and was thus used. The three selected rabbits were individually weighed and slaughtered after a 24-hour fast. The slaughtered animals were dressed by flaying, eviscerating and splitting according to Blasco and Ouhayoun (1993), as well as Blasco *et al*. (1993). The cut parts, namely, head, fore limb, thoracic cage, loin and hind limb, were dissected according to Blasco and Ouhayoun (1993) as described below:

The head was separated from the body by cutting it though the section between occiput and atlas vertebra.

The fore limb was separated by cutting it through section between the 7th and 8th thoracic vertebra following the prolongation of the rib when cutting the thoracic wall.

The thoracic cage was taken as a section between the last thoracic and the first lumber vertebra following the prolongation of the 12th rib when cutting the thoracic wall.

The loin section was between the 6th and 7th lumber vertebra cutting the abdominal wall transversely to the vertebral column.

The hind legs was separated by cutting it through the os coxae and posterior part of m. iliopsoas, m. psoas major and m. iliacus.

The paws were removed at the carpal and tarsal joints. The parts were weighed and recorded.

The dressed weight and dressing percentage were calculated as follows:

Dressed weight = Live Weight - Offal weight

where,

Offal weight = Gastro intetinal weight (GIT) + Internal Organs weight

Dressing out Percentage (DOP) % = (Dressed weight/Live weight) x 100

The weight of the internal organs, such as spleen, liver, kidney, lungs, heart and gastro intestinal tract, were also taken. The gastro intestinal tract was taken as the digestive tube from the point of decapitating the head to the anus comprising oesophagus, stomach, small intestine and the large intestine.

Cost Analysis

The prevailing market prices of the feed ingredients at the time of the experiment were used to estimate the unit cost of the experimental diet. Feed cost per kilogramme and cost per kilogramme of weight gain were calculated. The percentage feed cost saving of rabbits on restriction compared to the *ad libitum* fed rabbits was also determined (at the time of the experiment, one hundred and fifty five Naira (^), Nigeria National Currency was equivalent to One United States Dollar (^ 155.00 = US$ 1.00).

Data Analysis

The experimental diet samples were subjected to proximate analysis according to the methods of AOAC (1995). The detergent components were determined by the procedure developed by Goering and Van Soest (1970). Metabolisable energy (ME) value of the test diet was calculated by the method of Wardeh (1981). All data collected were subjected to statistical analysis appropriate for a completely randomized design layout using Minitab Analytical Computer Package (Minitab Inc., 1999). Significant differences between the treatment means were determined using the Duncan's Multiple Range Test (Steel & Torrie, 1990).

RESULTS AND DISCUSSION

The growth performance of rabbits subjected to varying dietary feeding regimes is presented in Table 2.

Final live weight, weight gain over the entire period, average daily gain and average daily feed intake over the 49-day experimental period were significantly ($P<0.05$) influenced by the feeding regimes employed. The least average daily weight gain over the entire period of the experiment was observed on the rabbits subjected to 60% *ad libitum* feeding throughout the experimental duration.

The average daily weight gain of these rabbits which was on the most severe restriction was 25.72% less than the average weight gain on the control feed regimen. The rabbits in Treatment 4 (80% *ad libitum* feeding for 3 weeks followed by 4 weeks of *ad libitum* feeding) showed a consistent similarity in performance with the rabbits on *ad libitum* feeding (Control). In terms of overall performance, the rabbits in Treatment 4, however, required less feed to gain a unit weight compared to the rabbits in the other treatments.

The rabbits on the Control treatment required significantly ($P<0.05$) more quantity of feed to gain a unit weight, an indication that it is less efficient. The nature of average weight gain over the period of feed regimentation is presented in Fig.1. As expected, from Week 1 through Week 3 (end of the restriction period), the rabbits restricted to 80 and 60% of the *ad libitum* intake presented a lower live weight than those fed *ad libitum*.

The rabbits previously restricted but later reverted to *ad libitum* feeding showed a steep rise in average daily weight gain from Week 4 onwards. The average daily gains during restriction were 11.32 and 9.72 g/day for the rabbits fed 80 and 60% of the *ad*

TABLE 2
Effect of feed restriction and realimentation on rabbit performance

	Treatments				
	T1 *Ad libitum* Feeding for 7 weeks	**T2** 80% *Ad libitum* Feeding for 7 weeks	**T3** 60% *Ad libitum* Feeding for 7 weeks	**T4** 80% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding	**T5** 60% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding
Av. Initial Weight (g)	800.10± 2.55	783.05± 6.80	766.00± 6..80	800.00± 6.50	783.10± 4.67
Av. Final Weight (g)	1545.92^{a}± 28.87	1385.00^{ab}± 57.74	1253.76^{b}± 43.34	1531.20^{b}± 16.67	1312.26^{ab}± 26.17
Weight Gain (g)	745.92^{a}± 18.02	602.00^{b}± 13.33	487.67^{c}± 13.64	731.20^{a} ± 10.02	609.28^{b}± 11.35
Av. DailyWeight Gain (g/day)	15.18^{a}± 0.57	12.29^{b}± 0.88	9.95^{c}± 1.02	14.92^{a}± 0.44	12.43^{b}± 0.91
Av. Daily Feed Intake (g/day)	92.67^{a}±4.46	61.95^{c}±16.55	52.83^{c}±8.19	73.71^{ab}±2.84	67.06^{b}±7.79
Feed: Gain	6.09^{b}± 0.57	5.04^{a}± 0.88	5.31^{ab}± 1.09	4.94^{a}± 0.21	5.39^{ab}± 0.90
*Cost/ Kg feed (^)	65.25	65.25	65.25	65.25	65.25
Cost/ Kg Weight Gain (^)	397.37^{c}± 10.57	328.86^{a}± 12.05	346.48^{b}± 9.07	322.34^{a}± 8.50	351.70^{b}± 8.78
% cost / kg gain compared to ad libitum	100.00	82.78	87.19	81.12	88.51

$^{a, b, c}$ Means within the same row with differing superscripts are significantly different (P<0.05)

(^) = Naira, Nigeria National Currency ^ 155.00 = US$ 1.00

libitum intake; however, in the last 4 weeks when *ad libitum* feeding was restored, average daily weight gains of 17.62 and 14.47% were obtained, respectively. These results were in agreement with the report by Perrier (1998), where a reduced level of intake (50% and 70% of the *ad libitum* intake) provoked a reduction of live weight (-32.9 and –20.5%, respectively) at the end of the restriction period (35-56 days).

Foubert *et al*. (2008) reported that a restricted feeding (70% of the *ad libitum* level) resulted in a lower live weight (-8.8%) at the end of restriction period (32-53 days). Tumova *et al*. (2002) also reported that during the restriction period, weight gain in the restricted rabbits was about 60-70% lower than in the *ad libitum* fed rabbits. The current results also confirm the results of Boisot *et al.* (2003), who observed that feed restriction (60% and 80% of the *ad libitum* level) elicited a lower live weight (respectively, -17.5 and -7%,) at the end of the restriction period (34-54 days).

The average daily feed intake for the entire period was significantly influenced by feeding strategy. The rabbits on continuous *ad libitum* feeding consumed significantly more feed than those in other feeding regimes. In addition, the rabbits on previously restricted but later *ad libitum* fed consumed significantly more feed than their continuously restricted counterparts. The feed intake pattern during the experiment is shown in Fig.2. The trend showed that the feed intake was consistently lower for

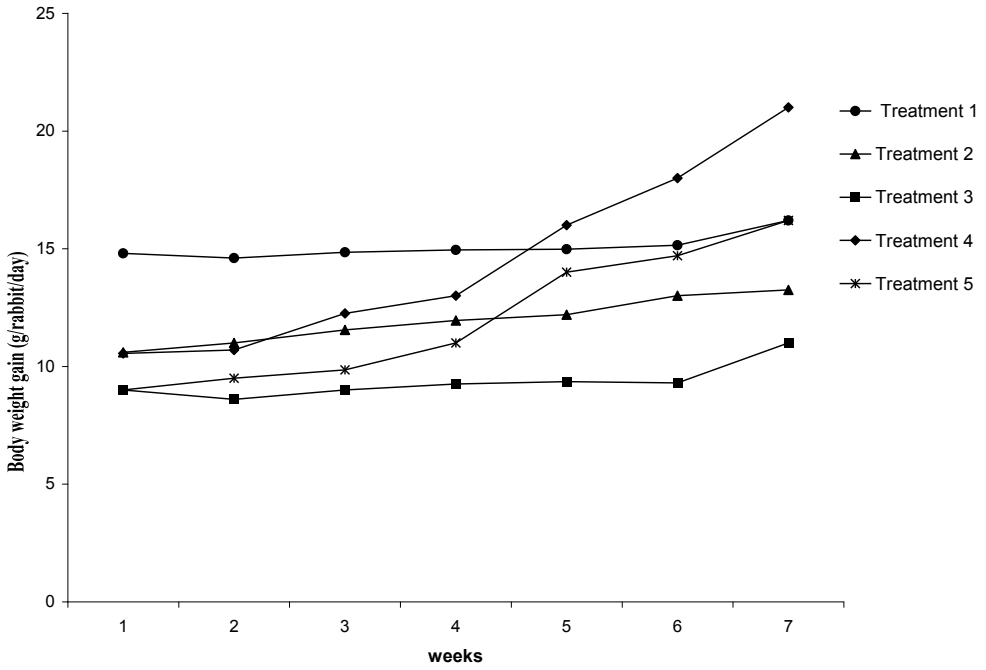

Fig.1: Weight change trend of rabbits subjected to feed restriction

the restricted-realimented rabbits compared with the continuously *ad libitum* fed rabbits. This observation was at variance with the report of Ledin (1984), that the restricted-fed rabbits during realimentation showed a tendency to consume more feed per day than those that were fed continuously *ad libitum*. On the contrary, the finding was in agreement with Boisot *et al.* (2003), who observed that the restricted rabbits (80% of *ad libitum* intake) had even lower daily feed intake (-18.4%, P<0.001) than the *ad libitum* ones during realimentation.

Feed conversion was significantly affected by the feeding regimens over the entire feeding period. The rabbits on continuous *ad libitum* feeding required more feed to attain a unit live weight gain compared to the rabbits on continuous feed restriction and those on restriction-realimented intake. The pattern of feed conversion measured as feed:gain is shown in Fig.3. In the restriction period (Week 1 - Week 3), the rabbits in Treatment 2 and Treatment 4 (80% *ad libitum*) had similar feed:gain. The same situation also occurred between the rabbits in Treatment 3 and Treatment 5 (60% *ad libitum*). While the feed:gain values for the rabbits on 80% *ad libitum* were higher than the values for the rabbits on *ad libitum* feeding, the values for the two groups on 60% *ad libitum* were lower than the values for the *ad libitum* fed rabbits in Week 1 and Week 2. However, from Week 3 up to the end of the feeding strategy, the rabbits on *ad libitum*

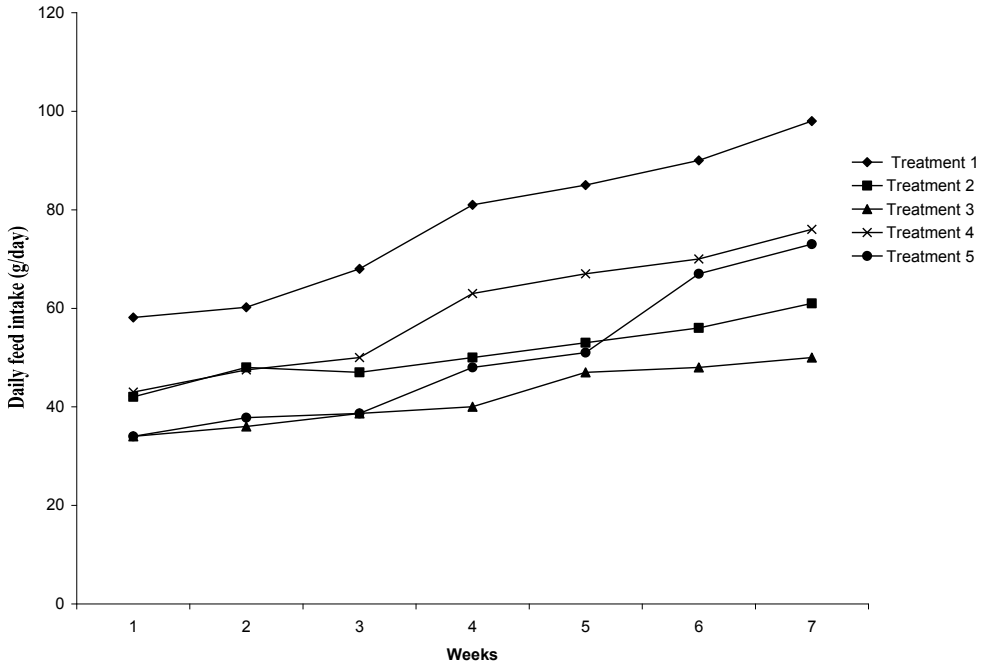

Fig.2: Feed intake trend of rabbits on different feeding strategies (g/rabbit/day)

feeding appeared to be less efficient as they required more feed to gain a unit weight. Similarly, improvements were noted in the feed conversion in the weight of the rabbits in Treatment 4 and Treatment 5 (80 and 60% *ad libitum* feeding during restriction followed by *ad libitum* feeding in the 4-week realimentation period). It was thus clear that during the realimentation (4-7 weeks), there was a favourable effect of feed restriction on feed conversion. This finding was in consonance with the previous reports of Boisot *et al.* (2003) and Foubert *et al*. (2008), in which significant favourable effects of feed restriction level were observed on feed conversion in the total fattening period.

The results were, however, at variance with that of Ledin (1984), who reported that in the entire growth period, the feed conversion was similar for the restricted-realimented and continuously *ad libitum* animals because the differences in the feed conversion efficiency in both periods (restriction and realimentation) tended to cancel each other. Meanwhile, Perrier (1998) found significant differences, but just for animals having a level of 50% intake of *ad libitum.*

The effect of treatments on economy of production measured as cost per kilogram weight gain indicated that restricting the feed by 20 and 40% without realimentation (T2 and T3) resulted in a reduction of 17.24 and 12.81% respectively as compared with the *ad libitum* fed control group. For the rabbits subjected to realimentation after the restriction period of 3 weeks, the savings in

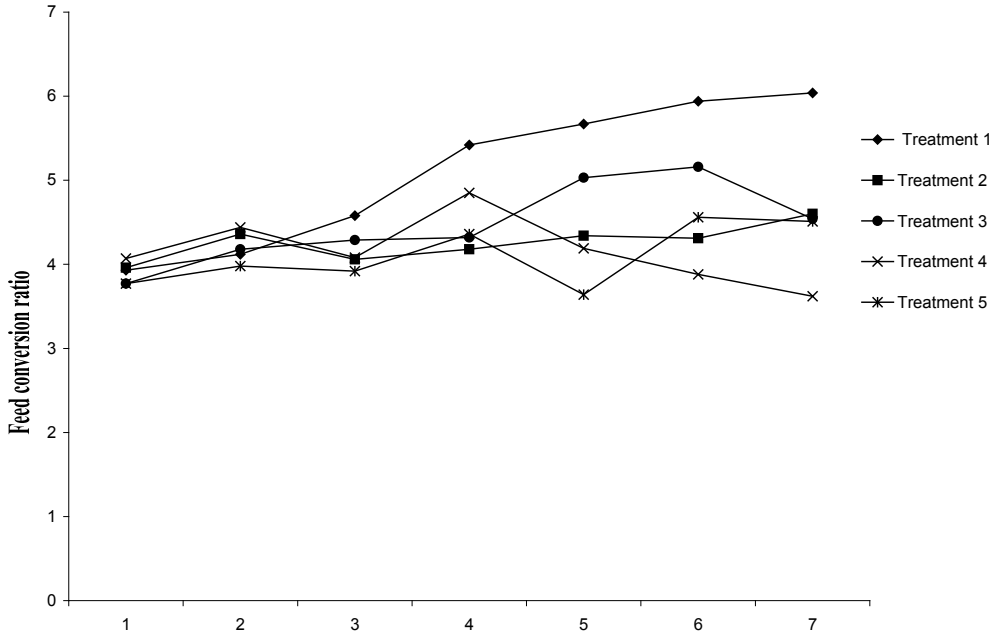

Fig.3: Feed conversion trend of rabbits on different feeding strategies (g feed: g weight)

feed cost per kilogramme weight gain were ^75.03 and ^ 45.67 representing 18.89 and 11.50% savings for T4 and T5 respectively compared with the control treatment (T1). It was observed that in terms of economic efficiency, the rabbits fed at 80% *ad libitum* feed intake (T4) were better than those on other treatments and the control. The superiority of the rabbits in T4 compared to the rabbits in the control (T1) arose from the fact that, although weight gain was similar between the two treatments, the amounts of feed required to attain the weight were however dissimilar.

The effects of treatments (feeding regimes) on carcass and retail cuts of the rabbits are presented in Table 3. Feed restriction regimes significantly influenced ($P<0.05$) dressed weight and dressing out percentage (DOP); however, there was no effect ($P>0.05$) on the fore limb, loin, hind limb and thoracic cage weights of the rabbit carcasses expressed as percentages of live weight.

The rabbits subjected to 80% *ad libitum* feeding in the first 3 weeks of feeding followed by *ad libitum* feeding in the last 4 weeks (T_4) had the highest dressed weight and dressing out percentage. The dressed weight and dressing out percentage obtained from the rabbits on *ad libitum* feeding throughout the feeding trial and those rabbits on 60% *ad libitum* feeding in the first 3 weeks of feeding followed by *ad libitum* feeding in the last 4 weeks were not different from each other. Similar results of no significant effect on dressed weight and dressing out percentages were obtained for the rabbits subjected to 80 and 60% *ad libitum* feeding throughout the 7-week duration. However, the values recorded for these two treatments were significantly lower than the values obtained from the other treatments. Perrier (1998) found lower dressing out percentage in cases of stricter restriction, which is similar to the observation in this study. The result of DOP was however in contrast with the results of Ferreira and Carregal (1996), Tůmova *et al.* (2003, 2006) and Boisot *et al*. (2004), who reported that restriction did not affect dressing percentage.

Other carcass traits were not affected by the feeding programmes, a finding that was in agreement with the report of Gidenne *et al*. (2009). Some earlier studies have shown little effect of feed restriction on relative organ weights, carcass portions, and meat quality (Matics *et al*., 2008; Tůmova *et al*. (2007).

The effects of feeding regimen on the organ weights of the rabbits are shown in Table 4. Feed restriction had no significant ($P>0.05$) influence on relative organ weights across the treatments. The present result was in consonance with the findings of Tumova *et al.* (2004), that there were no significant differences in the relative organ weights among the rabbits on *ad libitum* feeding and those on feed restriction.

CONCLUSION AND RECOMMENDATIONS

Restricting the amount of feed could be a suitable method for reducing feed intake and improving feed conversion. Compensatory

TABLE 3
Carcass and retail cuts weights of rabbit on different feed restriction regimes

Carcass characteristics	**T1** *Ad libitum* Feeding for 7 weeks	**T2** 80% *Ad libitum* Feeding for 7 weeks	**T3** 60% *Ad libitum* Feeding for 7 weeks	**T4** 80% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding	**T5** 60% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding
Liveweight (g)	$1440.90^{a} \pm 23.00$	$1369.10^{ab} \pm 17.12$	$1231.10^{b} \pm 18.28$	$1480.53^{a} \pm 23.15$	$1380.00^{ab} \pm 21.38$
Dressed weight (g)	$871.31^{b} \pm 16.62$	$764.32^{bc} \pm 14.14$	$681.11^{c} \pm 12.28$	$951.54^{a} \pm 11.37$	$850.49^{b} \pm 14.31$
Dressing out percentage (%)	$60.47^{b} \pm 4.33$	$55.83^{c} \pm 5.15$	$55.33^{c} \pm 7.41$	$64.27^{a} \pm 4.48$	$61.63^{b} \pm 5.72$
Head (% LW)	7.83 ± 0.12	8.03 ± 0.08	8.10 ± 0.10	8.23 ± 0.10	7.83 ± 0.12
Forelimb (% LW)	8.39 ± 0.11	7.81 ± 0.13	9.05 ± 0.13	8.37 ± 0.19	7.11 ± 0.14
Loin (% LW)	10.10 ± 0.10	10.87 ± 0.11	10.50 ± 0.11	12.20 ± 0.11	10.23 ± 0.12
Hind limb (% LW)	19.37 ± 2.33	18.57 ± 1.49	18.43 ± 3.20	20.23 ± 2.78	19.00 ± 2.40
Thoracic (% LW)	10.30 ± 0.30	10.23 ± 0.22	9.70 ± 0.35	11.83 ± 0.24	10.65 ± 0.20

[a, b, c] Means within the same row with differing superscripts are significantly different ($P<0.05$)

TABLE 4
Relative organ weight of rabbit on varying durations of feed restriction (% Liveweight)

Organs	**T1** *Ad libitum* Feeding for 7 weeks	**T2** 80% *Ad libitum* Feeding for 7 weeks	**T3** 60% *Ad libitum* Feeding for 7 weeks	**T4** 80% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding	**T5** 60% *Ad libitum* feeding for 3 weeks followed by 4 weeks *ad libitum* feeding
Liver (% LW)	2.54 ± 0.35	3.29 ± 0.28	2.10 ± 0.29	3.00 ± 0.31	3.09 ± 0.26
Kidney (% LW)	0.68 ± 0.06	0.63 ± 0.08	0.53 ± 0.03	0.50 ± 0.05	0.55 ± 0.06
GIT* (% LW)	20.57 ± 0.27	20.23 ± 0.32	19.50 ± 0.26	21.17 ± 0.22	20.90 ± 0.24
Spleen (% LW)	0.14 ± 0.03	0.17 ± 0.01	0.50 ± 0.35	0.14 ± 0.03	0.15 ± 0.02
Heart (% LW)	0.43 ± 0.02	0.41 ± 0.01	0.40 ± 0.02	0.42 ± 0.01	0.41 ± 0.02

- Gastro intestinal tract

growth was observed in the rabbits subjected to restriction but later *ad libitum* fed. Body weight compensation was almost complete in the rabbits of T4, which was similar to the weight obtained on the control treatment (*ad libitum* feeding). Concerning the carcass traits, the observed decrease in dressing out percentage with increasing stiffness of restriction is an indication of the fact that feed restriction may have its own disadvantages except when realimentation is allowed for adequate period.

From the findings of this study, it is recommended that growing rabbits can be subjected to a three-week feed restriction of not more than 20% provided at least four weeks of *ad libitum* feeding is allowed for compensatory growth.

REFERENCES

A. O. A. C. (1995). *Official Methods of Analysis*. Association of Official Analytical Chemists (16th Edn.). Washington D.C.

Adeyemi, O. A., Sobayo, R. A., Aluko, F. A., & Oke, D. B. (2008). Utilisation of rumen filtrate fermented corn-cobs by weaner rabbits. *Nig. J. Anim. Prod*., *35*(1), 69-75.

Blasco, A.,& Ouhayoun, J. (1993). Harmonization of criteria and terminology in rabbit meat research. Revised proposal. *World Rabbit Sci*., *4*(2), 93-99.

Blasco A., Ouhayoun, J., & Masoero, G. (1993). Harmonization of criteria and terminology in rabbit meat research. *World Rabbit Sci., 1,* 3-10.

Boisot, P., Licois, D., & Gidenne, T. (2003). *Feed restriction reduces the sanitary impact of an experimental reproduction of Epizootic Rabbit Enteropathy Syndrom (ERE), in the growing rabbit*. 10ème Journées Recherche. Cunicoles Française. p. 267-270.

Boisot P., Duperray, J., Dugenetais, X., & Guyonvarch, A. (2004). *Interest of hydric restriction times of 2 and 3 hours per day to induce feed restriction in growing rabbits*. In Proc. 8th World Rabbit Congress, September7–10, Puebla, Mexico. 759–764.

Ferreira R. G., & Carregal, R. D. (1996). *A note on carcass characteristics of rabbits fed on a restricted system*. In Proc. 6th World Rabbit Congress, July 9–12, Toulouse, France. 163–165.

Feugier, A. (2002). *Incidence d'un rationnement quantitatif sur la croissance, la digestion et l'état sanitaire du lapin*. Ed. ISARA. 1- 41.

Foubert, C., Boisot, P., Duperray, J., & Guyonvarch, A. (2007). *Interêt d'un accès limité à la mangeoire de 6h, 8h et 10 h pqr jour pour engendrer un rationnement alimentaire chez le lapin en engraissement*. 12èmes Journées de la recherche Cunicole. 123-126.

Gidenne, T., Combes, S., Feugier, A., Jehl, A., Arveux, P., Boisot, P., Briens, C., Corrent, E., Fortune, H., Montessuy, S., & Verdelhan, S. (2009). Feed restriction strategy in the growing rabbit. 2. Impact on digestive health, growth and carcass characteristics. *Animal*, *3*(4), 509–515.

Goering, H. K., & van Soest, P. J. (1970). Forage analysis *(Apparatus, Reagents, Proceedings and some applications)*. Agric. Handbook No.379 ARS. USDA, Washington D. C.

Halls, A. E. (2010). Nutritional Requirements of Rabbits. Retrieved from http://www.nutrecocanada.com/docs/shur-gain---specialty/nutritional-requirements-of-rabbits

Ledin, I. (1984a). Effect of restricted feeding and realimentation on growth, carcass composition and organ growth during the first seven days of realimentation in rabbit. *Acta Agric. Scand. 34*, 54-66.

Ledin, I. (1984b). A note on the effect of different feeding levels on the rate of digesta passage in rabbits. *Acta Agric. Scand*., *34*, 67-70.

Maertens, L., & Peeters, J. E. (1988). Effect of a feed restriction after weaning on fattening performances and caecal traits of early weaned rabbits. 6. Arbeitstagung über Peltztiere, Kaninchen und Heimtier production und Krankenheit. *Celle 2-4 Juni*, 158-169.

Matics, Z. S., Dalle Zotte, A., Radnai, I., Kovács, M., Metzger, Z. S., & Szendrı, Z. S. (2008). *Effect of restricted feeding after weaning on the productive and carcass traits of growing rabbits.* In the Proceeding of 9th World Rabbit Congress – June 10-13, 2008 – Verona – Italy pp 741-745

Merck Manual (2011). *Nutritional Requirements of Rabbits*. Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc. Whitehouse Station, New Jersey, USA. Retrieved from http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/171315.htm

Minitab Inc. (1999). *Minitab Data Analysis System*. Release 7.1 Standard Version Serial. Minitab Inc.

Perrier, G. (1998). Influence de deux niveaux et de deux durées de restriction alimentaire sur l'efficacité productive du lapin et les caractéristiques bouchères de la carcasse. 7ème *Journées. Recherche. Cunicole Française,* 179-182.

Perrier, G., & Ouyayoun, J. (1996). Growth and carcass traits of the rabbit: a comparative study of three modes of feed rationing during fattening. *6th World Rabbit Congress, 3*, 225-231.

Steel, R. G. D., & Torrie, J. H. (1980). *Principles and Procedures of Statistics* (2nd Edn.). USA: McGraw Hill Book Co., Inc.

Szendrõ, Z. S., Mihálovics, G. Y., Milistis, G., Biró-Németh, E., & Radnai, I. (2000). Effect of reduction of feeding time on the performances and carcass quality of growing rabbits. 7th *World Rabbit Congress, 6*.

Tumova, E., Sk Ivan, M., Sk Ivanová, V., & Kacerovská, V. (2002). Effect of early feed

restriction on growth in broiler chickens, turkeys and rabbits. *Czech Journal of Animal Science, 10*, 418-428.

Tůmová, E., Skřivanová, V., & Skřivan, M. (2003). Effect of restricted feeding time and quantitative restriction in growing rabbits. *Arch. Geflűgelkde*, *67*, 182 -190.

Tůmova E., Zita, L., & Štolc, L. (2006). Carcass quality in restricted and *ad libitum* fed rabbits. *Czech J. Anim. Sci., 51*(5)*, 214–219.*

Tumová, E, Zita, L., Skrivanová, V., Fucíková, A., Skrivan, M., and Burešová, M. (2007). Digestibility of nutrients, organ development and blood picture in restricted and ad libitum fed broiler rabbits. *Arch.Geflügelk., 71*(1), S. 6–12.

Wardeh, M. F. (1981). *Methods for estimating energy and protein utilization of feed*. PhD Dissertation. Utah State University. Logan. US.