Growth performance and linear body measurements of gestating rabbit subjected to varying level of feed restrictions

¹Adeyemo, A. A., ^{1*}Njoku, C. P., ¹Adeyemi, O. A., ¹Sogunle, O. M. and ²Bamgbose, A. M.

¹Department of Animal Production and Health,

²Department of Animal Nutrition,

Federal University of Agriculture, Abeokuta, Nigeria

*Corresponding author: njokucp@funaab.edu.ng;

+2348034647741; +2348023741145

Abstract

To optimize production and ensure sustainability, there is need for judicious management of the resources employed in livestock production enterprise. For inefficient utilization of resources can jeopardize or hamper livestock production and availability. This present study was conducted to determine the performance and changes in morphological parameters of rabbit does subjected to quantitative feed restriction at different periods of gestation. A total of seventy-two rabbits does with initial live weight range of 1.7-2.0 kg were employed in this study. The study was arranged in a 3x3 factorial layout. The rabbits were divided into nine treatments of eight does per treatment and exposed to three levels of feed restrictions (0, 15, 30%) at different gestation periods (15-19, 20-24, 25-29 days). Water was supplied ad libitum throughout the experimental period. Data were collected and documented for analysis on feed intake, weight gain, changes in linear body parameters and gestation length. Significant ($p < 0.05$) differences were noted for final weight, weight gain, feed gain, feed intake and gestation length. Restriction at 15% recorded highest final and weight gain. Longest gestation length was recorded for does on 30% restriction. Interaction between restriction and periods of gestation shows significant ($p < 0.05$) differences in weight gain, feed gain, feed intake and gestation length. All the morphological parameters considered in this present study were not influenced ($p > 0.05$) by restricted feeding and periods of feed restriction. Therefore, it can be concluded that 15% feed restriction could be applied at 20-24 days of gestation without any adverse effect on maternal well-being.

Keywords: Gestation, morphology, maternal, pregnancy, realimentation

Introduction

The demand for livestock products will continue to rise in response to ever increasing human population. The human population growth in developed countries is stabilizing while that of developing countries including Nigeria is still increasing rapidly. Thus, the search for alternative sources of protein to meet up the population challenge is imperative. Economic indices indicate that as this population trend continues, more people have to be fed. Agricultural outputs need to be increased rather than through food importation into such countries (Allen, 1993). In order to maximize food production and meet protein requirements

in Nigeria, viable options need to be explored and evaluated as the conventional animal protein sources are being overstretch beyond its elastic limit by population growth (Owen *et al.*, 2008). One of these viable options to be considered is commercial rabbit farming. Rabbit production is characterised by short gestation period, high fecundity, small capital requirement, quick investment returns and ability to utilize forages (Biobaku and Dosunmu, 2003). Despite these advantages, poor resources management and nutritional technology coupled with high cost of feed ingredients have been identified among others as the limiting factors in commercial rabbit

production in developing countries (Obih and Ekenyem, 2010). Foetal growth is dependent on an adequate supply of oxygen and nutrients from their mothers' placenta (Robinson *et al.*, 1994). Since, nutrient supply to embryos and foetus is exclusively dependent upon the dam (Szendro *et al.*, 2001). The prolificacy and lifetime performance of rabbit does are partly determined by their body condition (Fortun-Lamonthe, 1997). The rabbit breeds with rapid growth are prone to overfeeding. Overfed does at first kindling are more sensitive to dietary fluctuations. A reduction in intake after the first parturition can create a quick emaciation of these does, causing higher frequency of disease problems (Le roux *et al.*, 1998). Thus, to obtain a breeding flock with adequate body condition, it is suggested that the growth of young rabbits should be restricted by limiting their feed supply during growing period. Feed restriction could also be exploited in the feeding regimen of rabbits, especially in periods of inadequate supply of concentrates and forages (Yakubu *et al.*, 2007). Feed restriction has been studied in order to improve biological and economic performance. Restricted feeding induces compensatory growth, increases feed efficiency (Tůmova *et al.* 2003; Dalle Zotte *et al.* 2005), improves digestibility of nutrients (Tůmova *et al.* 2003, 2004) and prevent post-weaning digestive disorders (Boisot *et al.* 2004). Although, feed restriction has been used as management tool to improve the feed efficiency, carcass quality and well-being of fast growing domestic animals (Njoku *et al.*, 2012, 2013), however, more information is needed to determine the effect of quantitative restriction on maternal growth and morphological parameters of gestating rabbit does. To this effect, this study was carried out to evaluate the effects of

quantitative feed restriction and periods of feed restriction on gestating rabbit does and changes in their linear body measurements of rabbits raised in hot humid tropical environment.

Materials and methods

The experimental protocols involving the use of animals were in compliance with the animal welfare requirements for care and management of experimental animal and was approved by the Animal Welfare Committee of the Federal University of Agriculture, Abeokuta

Experimental site

The experiment was carried out at the Rabbitry Unit of the Directorate of University Farms, Teaching and Research Section, Federal University of Agriculture, Abeokuta, Nigeria. The farm lies within latitude 7°10' N, longitude 3°2' E and altitude 76 mm. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of about 1037 mm and temperature of about 34.7°C. The relative humidity ranges from 63 to 96% in the rainy season (late March to October) and from 55 to 82% in the dry season (November to early March) with an annual average of 82%. The seasonal distribution of annual rainfall is approximately 44.96 mm in the late dry season (January-March); 212.4 mm in the early wet season (April-June); 259.3 mm in the late wet season (July-September) and 48.1 mm in the early dry season (October-December) as recorded in Google Earth (2016).

Experimental animals and management

Seventy-two 20 weeks' old doe rabbits of mixed breeds (Chinchilla x Dutch x New Zealand) with initial live weight of 1.7-2.0 kg were used for the study. The does were divided into nine treatment groups of eight rabbits each after balancing for weight and housed individually in cells of dimension

0.8×0.5×0.6 m. The hutches were washed and disinfected prior to the commencement of the experiment.

Experimental design

Treatments consisted of three levels of concentrate feed restriction fed at three different periods during the latter half of the pregnancy period after ascertaining pregnancy by palpation. The experimental does were exposed to three levels of restricted concentrate feeding (0, 15 and 30%) at three periods of gestation (15-19, 20-24, 25-29 days) in a 3 x 3 factorial arrangement. The composition of concentrate diet fed is shown in Table 1. Rabbits on 0% restriction were offered 100 grams of feed daily throughout the experimental period. Those on 15%

restriction were offered 85 g from 15–19th days of pregnancy and later reverted to full feeding till parturition. Another set of rabbits were offered restricted feeding from 20–24th days of pregnancy, thereafter they were offered 100 grams of feed till parturition. The last group was fed 85 grams of feed from 25–29th days of pregnancy and later full fed till parturition. Those on 30% restriction were offered 70 grams from 15–19th days of pregnancy and later reverted to full feeding till parturition. Another set of rabbits were offered restricted feeding from 20–24th days of pregnancy, thereafter they were offered 100 grams of feed till parturition. The last group was fed 85 grams of feed from 25–29th days of pregnancy and later full fed till parturition.

Table 1: Composition of concentrate diet (%)

Ingredients	%
Maize	47.50
Fish meal	2.00
Soybean meal	3.00
Wheat offal	23.00
Groundnut cake	12.00
Rice husk	7.00
Bone meal	3.00
Oyster shell	2.00
Salt (NaCl)	0.25
*Vitamin and Mineral premix	0.25
Total	100
Determined Analysis (%)	
ME (Kcal/kg)	2578.8
Ash	2.74
Crude fibre	10.65
Crude protein	16.20
Nitrogen free extract	42.50

*Contained the following per kg diet vit A 10000000 IU; Vit D3 2500000 IU ; Vit E 40000 IU ; Vit K3 4000 mg, Vit B1 750 mg, Vit B2 2000 mg, Vit B6 2000 mg, Vit B12 10 mcg, Niacin 13000 mg, Pantothenic Acid 5000 mg, Folic Acid 1000 mg, Biotin 10 mcg, Choline Chloride 50000 mg, Manganese 50000 mg, Zinc 100000 mg, Iron 80000 mg, Copper 50000 mg, Iodine 1000 mg, Selenium 200 mg, Cobalt 500 mg, Antioxidant 120000 mg

Data collection

Records of weekly feed intake, weight gain, gestation length and changes in linear body measurements (ear length, heart girth, body length, tail and head to shoulder lengths) of

rabbit does were taken and documented on weekly basis for 8 weeks while feed conversion ratio was calculated as:

Feed Conversion Ratio =

$\frac{\text{Average Feed intake (g/rabbit)}}{\text{Average Daily Weight Gain (g/rabbit)}}$

Growth performance and linear body measurements of gestating rabbit

Linear body measurements

Linear body measurements of gestating does taken include: Ear length (EL), tail length (TL), heart girth (HG), head to shoulder (HTS) and body length (BL). These measurements were taken on weekly basis for a period of eight weeks with the aid of a tape rule following the procedures of Akanno and Ibe (2006). Ear length was determined by measuring the tip of the ear to the junction of the ear at the level of the skull. Head to shoulder length was measured from the tip of the nose to the end of the cervical vertebra. Heart girth was determined by measuring the circumference of the chest region directly below the fore arms. Tail length was taken from the junction of the hip to the tip of the tail while body length involves measuring the length from the tip of the shoulder to the tip of the pelvic.

Statistical analysis

Data were arranged in a 3×3 factorial experimental layout and then subjected to one-way analysis of variance using SAS (2000). Significantly ($p<0.05$) means were separated using New Duncan Multiple Range Test as outlined in SAS (2000) statistical package.

Results

Effects of feed restriction levels and periods of restriction on performance of gestating does

Table 2 shows the effects of feed restriction levels and periods of restriction on performance of gestating does. Significant ($p<0.05$) differences were noted in the final weight, weight gain, feed conversion ratio, average daily feed intake during restriction period and gestation length. Final weight and weight gain at gestation decreased significantly ($p<0.05$) with increased level

feed restrictions. The does on ad libitum feeding had the highest final weight and weight gain (2 414.16 g and 530.00 g) while those on 30% feed restriction recorded the least final weight and weight gain values (2 221.33 g and 397.67 g). Significant differences were also obtained on the feed conversion ratio with 0% level of feed restriction having the poorest value (6.15) while does on 30% feed restriction recorded the best value (4.52). The levels of feed restriction have significant ($p<0.05$) effect on average daily feed intake during restriction period. There were no significant ($p>0.05$) differences on average feed intakes of gestating does before restriction and realimentation periods. Gestation length values (29.00, 30.00, 31.08 days) increased significantly ($p<0.05$) with increase in level of restriction. The periods of feed restriction did not affect ($p>0.05$) the final weight, weight gain, feed conversion ratio, average daily feed intake before restriction and gestation length. However, significant ($p<0.05$) differences were obtained on average daily feed intake during restriction and realimentation periods. Average daily feed intake during restriction increased ($p<0.05$) as the periods of restriction increases, with gestating does restricted at 25-29th days of gestation period having the highest value of 78.10 g/rabbit/day while does restricted during the 15-19th days of gestation had the least value of 73.25 g/rabbit/day. The same trend was observed for average daily feed intake during realimentation period, gestating does on restriction at 25-29th days of pregnancy had the highest mean values while those restricted at 15-19th days recorded the least mean value.

Table 2: Main effect of levels and periods of feed restriction on performance of gestating does

Parameters	Levels of feed restriction			SEM	Periods of restriction (days)			SEM
	0%	15%	30%		15-19	20-24	25-29	
Initial Weight (g)	1823.66	1884.16	1848.33	26.53	1815.83	1912.41	1827.91	27.17
Final Weight (g)	2414.16 ^a	2258.3 ^b	2221.33 ^c	54.46	2263.33	2367.41	2263.08	54.94
Weight gain (g)	530.00 ^a	410.00 ^b	397.67 ^c	23.06	447.50	455.00	435.16	42.31
Feed conversion ratio	6.15 ^a	5.92 ^b	4.52 ^b	0.22	5.51	5.34	5.74	0.32
Av.F.I.B.RES (g/rabbit/day)	79.47	78.88	78.69	1.96	80.44	77.44	79.16	3.99
Av. F. I. DU RES (g/rabbit/day)	86.08 ^a	74.90 ^b	67.78 ^c	2.41	73.25 ^b	77.40 ^a	78.10 ^a	3.89
Av. F. I. DU. REA (g/rabbit/day)	89.23	89.35	86.40	1.05	85.68 ^b	87.01 ^b	91.11 ^a	1.35
Gestation Length (Days)	29.00 ^c	30.00 ^b	31.08 ^a	0.48	29.66	29.66	30.75	0.28

^{a, b, c}: Means in the same row with different superscripts differ significantly ($p < 0.05$)

AV.F.I.B.RES: Average daily feed intake before restriction.

AV.F.I.DU.RES: Average daily feed intake during restriction.

AV.F.I.DU.REA: Average daily feed intake during realimentation

SEM: Standard error of mean

Interaction between levels of feed restriction and periods of feed restriction on performance of gestating does

Table 3 shows the interaction between levels of feed restriction and periods of restriction on growth performance of gestating does. Significant ($p < 0.05$) differences were obtained on the final weight, weight gain, feed conversion ratio, average daily feed intake during restriction and realimentation periods, and gestation length. Gestating does on 15% level of feed restriction at 20-24th days recorded the highest final weight value of 2 567.50 g compared to those on 0% level of feed restriction at 15-19th day which had the lowest value 2 220.00 g. Feed conversion ratio was significantly ($p < 0.05$) influenced by the interaction between levels and periods of feed restriction with gestating does on 0% feed restriction at 15-19th days recording the poorest value of 6.18 compared to 4.24 that was recorded for gestating does on 15% feed restriction at 20-24th days of pregnancy. Significant ($p < 0.05$) differences were obtained for average daily feed intake of gestating rabbit does during restriction and realimentation periods. Gestating does on 0% feed restriction level at 15-19th days of gestation had the highest value of 87.39 g for average daily feed intake during restriction compared to 63.34 g noted for does at 30% feed restriction level on 15-19th days of

gestation period. Average daily feed intake during realimentation differed significantly ($p < 0.05$) across the treatment groups. Gestating does on 15% feed restriction level at 25-29th days of pregnancy recorded the highest value (94.87 g) while those on 30% feed restriction level at 15-19th days recorded the lowest value of 82.99 g. Does subjected to 30% restriction level at 25- 29th days of pregnancy had the longest gestation length of 33 days compared to other periods of restriction.

Effects of levels and periods of feed restriction on changes in linear body measurements of gestating rabbit does

Table 4 shows the effects of levels and periods of feed restriction on changes in linear body measurements of gestating rabbit does. Levels of feed restriction significantly ($p < 0.05$) influence ear lengths and heart girths, ear length values ranged from 0.04 cm (does on 30% restriction) to 0.17 cm (does on 0% restriction level) while that of the Heart girth ranges from 0.29 cm for does on 15 and 30% restriction level to 0.50cm obtained for those on 0% restriction level. Head to shoulder, tail length and body length were not significantly ($p > 0.05$) influenced by the dietary feed restriction levels. The periods of feed restriction had no significant ($p > 0.05$) effect on in all linear body measurement parameters considered (ear length, head to shoulder, heart girth, tail length and the body length).

Table 3: Interaction between levels and periods of feed restriction on performance of gestating does

Parameters/ Periods of feed restriction (days)	0%			15%			30%			SEM
	15-19	20-24	25-29	15-19	20-24	25-29	15-19	20-24	25-29	
Initial weight (g)	1825.00	1822.25	1823.75	1792.50	2012.50	1847.50	1830.00	1902.50	1812.50	46.06
Final weight (g)	2220.00 ^b	2222.25 ^b	2221.75 ^b	2337.50 ^b	2567.50 ^a	2337.50 ^b	2232.50 ^b	2312.50 ^b	2230.00 ^b	73.63
Weight gain (g)	395.00 ^{ab}	400.00 ^{ab}	398.00 ^{ab}	545.00 ^a	555.00 ^a	490.00 ^a	402.50 ^{ab}	410.00 ^{ab}	417.50 ^{ab}	55.21
Feed conversion ratio	6.18 ^a	6.11 ^a	6.15 ^a	4.52 ^b	4.24 ^b	4.83 ^b	5.85 ^b	5.67 ^b	6.24 ^a	0.42
Av.F.I.B.RES. (g/rabbit/day)	79.90	78.57	79.95	81.08	77.19	78.30	80.35	76.57	79.16	2.12
Av.F.I.DU.RES. (g/rabbit/day)	87.39 ^a	84.66 ^a	86.18 ^a	69.03 ^c	77.55 ^b	78.13 ^b	63.34 ^c	70.00 ^b	70.00 ^b	1.43
Av.F.I.DU.REA. (g/rabbit/day)	88.70 ^a	86.23 ^{ab}	89.23 ^a	89.34 ^a	83.86 ^{bc}	94.87 ^a	82.99 ^{bc}	86.96 ^{ab}	89.25 ^a	1.15
Gestation Length (days)	29.00 ^c	29.00 ^c	29.00 ^c	30.00 ^b	30.00 ^b	30.00 ^b	30.00 ^b	30.00 ^b	33.25 ^a	1.61

^{a, b, c}; Means in the same row with different superscripts differ significantly ($p < 0.05$)

AV.F.I.B.RES: Average daily feed intake before restriction.

AV.F.I.DU.RES: Average daily feed intake during restriction.

AV.F.I.DU.REA: Average daily feed intake during realimentation

SEM: Standard error of mean

Table 4: Effects of levels and periods of feed restriction on changes in linear body measurements of gestating does

Parameters	Levels of feed restriction				Periods of feed restriction (days)			
	0%	15%	30%	SEM	15-19	20-24	25-29	SEM
Ear length (cm)	0.17 ^a	0.09 ^{ab}	0.04 ^b	0.02	0.12	0.10	0.07	0.03
Head to shoulder (cm)	0.23	0.24	0.20	0.03	0.24	0.217	0.21	0.03
Heart girth (cm)	0.50 ^a	0.29 ^b	0.29 ^b	0.09	0.55	0.47	0.55	0.16
Tail length (cm)	0.05	0.06	0.05	0.02	0.08	0.08	0.05	0.02
Body length (cm)	0.64	0.76	0.67	0.08	0.68	0.72	0.67	0.13

^{a, b}: Means on the same row with different superscripts differ significantly ($p < 0.05$) SEM: Standard error of mean

Interaction between levels and periods of feed restriction on changes in linear body measurements of gestating does

Table 5 shows the interaction between feed restriction and periods of restriction on changes in linear body measurements of

gestating does. The interaction between levels of feed restriction and period of feed restriction had no significant ($p > 0.05$) effect on ear length, length of head to shoulder, heart girth, tail length and the body length.

Table 5: Interaction between levels and periods of feed restriction on changes in linear body measurements of gestating does

Levels of feed restriction	0%			15%			30%			SEM
	15-19	20-24	25-29	15-19	20-24	25-29	15-19	20-24	25-30	
Parameters/Periods of feed restriction (days)										
Ear length (cm)	0.17	0.17	0.15	0.15	0.10	0.02	0.05	0.05	0.02	0.02
Head to shoulder (cm)	0.25	0.20	0.25	0.27	0.25	0.20	0.20	0.20	0.20	0.05
Heart girth (cm)	1.00	1.00	1.00	0.32	0.15	0.40	0.32	0.27	0.27	0.25
Tail length (cm)	0.07	0.10	0.12	0.10	0.10	0.00	0.07	0.05	0.05	0.03
Body length (cm)	0.62	0.62	0.67	0.77	0.87	0.65	0.65	0.67	0.70	0.25

SEM: Standard error of mean

Discussion

The study revealed lower body weight in gestating does fed different levels of feed. The observed differences could be attributed to insufficient nutrient intake by the gestating does on restriction. The result obtained is in harmony with the work of Njoku *et al.* (2013) and Merck (2008) they assert that the performance of livestock is related to quality and quantity of feed consumed by the animal on daily basis. Manal *et al.* (2004), posited that restricted feeding could have negative effects on body weight gain of rabbits which is contingent on the amount of feed offered to the rabbits per time. Better feed conversion ratio values were noted for the restricted groups when compared with the value documented

for *ad libitum* fed gestating does. This indicates that the restricted group were able to utilized nutrients in feed maximally than their counter parts on *ad libitum* feeding. This observation is in line with the study of Njoku *et al.* (2012), who observed improved nutrient digestibility and better feed efficiency in feed-restricted pigs over their full fed counterparts. Extraneous physiological factors such as feed intake, body weight decrement and stress can have effect on the rate of development of foetus since nutrient supply to embryos and foetuses is principally dependent on the dam. Reduction in nutrient intake might have led to the significant increase in gestation length with increasing level of restriction as observed in this present study.

Growth performance and linear body measurements of gestating rabbit

The significant difference in gestation length is in line with the observation of Rossdale and Ousey (2002) but varied from the report of Brecchia *et al.* (2012) who reported no significant difference in the duration of pregnancy of full fed and feed-restricted rabbits. Barker (1998) posited that reduction in voluntary feed intake during pregnancy accounted for significant proportion of intrauterine growth retardation. Also, Rasmussen (1998) reported that restricted-pregnant animals mobilized body fat and reduced their energy expenditure for maintenance and activity. Marty *et al.* (2003) found that feed restriction produced no significant delays in pubertal onset. However, Stoker *et al.* (2000) observed a significant delay in age at preputial separation in feed-restricted animals.

Duration and degree of feed restriction could necessitate negative effects on body weight gain of rabbits (Manal *et al.*, 2004). The comparable mean values noted in the final weight and weight gain of gestating does in this present study could be attributed to similarity in degree and duration of restriction. The biological demands of nutrients by does must have been met from the amount of feed supplied. This result conformed to the study of Manal *et al.* (2010) who recorded similarity in weight gain of restricted and non-restricted pregnant nulliparous rabbit does. Restricting the feed of gestating does at 25-29 days of pregnancy resulted to least numerical value in weight gain. Many researchers reported a decline in appetite of does at this period of pregnancy and increase in the nutritional requirements of the rapid growing foetus, resulting to negative nutritional balance that might have affected the rate of body weight gain since the does will have to mobilize their body reserve to satisfy the needs of their developing foetus (Manal *et al.*, 2010). Gestating does on feed restriction at 20-24

days and 25-29 days of gestation periods had similar average daily feed intake values which differed significantly from the does on restriction at 15-19 days of gestation. The observed differences in daily feed intake of these does may be attributed to the higher nutrient requirements for the development of foetuses in the last trimester of pregnancy (Fortun-Lamothe, 2006). Moreover, Coudert and Lebas (1985) recommended that feed restriction should not be carried out on pregnant rabbit during the last trimester. Literature is dotted with the fact that after restriction period, there is an increase in the appetite of rabbits leading to a sharp increase in voluntary feed intake that could induce a compensatory increase in weight that allows recovery of lost weight in rabbits subjected to feed restriction (Tumova *et al.*, 2003, 2004; Brecchia *et al.*, 2012). The data obtained for average daily feed intake during realimentation period are in agreement with the earlier observations with the highest mean value obtained by gestating does whose feed intake was restricted on 24-29 days of pregnancy.

The result obtained for interaction shows that gestation length was 29 days for all the periods of gestating does on 0% level of feed restriction and likewise in 15% restriction level, the gestation length was 30 days for all the periods studied, this corroborate the result of Brecchia *et al.* (2012) that reported 30-31 days for rabbits does fasted during pregnancy. However, does subjected to 30% restriction level between 25- 29 days had the longest gestation length of 33 days compared to other periods of restriction (15-19 and 20-24 days). The intensity of restriction must have compromised the rate of development of the embryo leading to a prolong gestation period and this supported the work of Rasmussen (1998) that reported that feed-restricted female animals mobilized body fat and reduced their energy expenditure for

maintenance and activity especially when feed restriction occurred shortly before parturition.

The similarities in values obtained for the body length of rabbits fed different levels of feed is line with the study of Njoku *et al.* (2013) who observed no significant difference in the body length of finishing pigs fed different quantity of feed. The significant difference noticed in the ear length and heart girth could be attributed to the differences in the final weight of the gestating does since body morphological parameters have been used to assess body dimensions to overall body size and weight. The observed differences in some of the linear body measurements (ear length and heart girth) conform to the observations of Onyimonyi *et al.* (2010) and Njoku *et al.* (2013). They posited that changes in morphological traits are indicators of tissue growth and tend to increase with body weight. Periods of restriction had no effect on all the morphological parameters considered in this present study. The non-significant effect observed in the morphological traits studied could be connected with the short duration of feed restriction period (5 days). The gestating does could have utilised their body reserved more efficiently to compensate for the limited nutrient supply since the period of feed restriction was short. Feeding patterns, degree and durations of feed restriction are among the factors that influence growth rate of livestock (Donker *et al.*, 1986; Critser *et al.*, 1995; Njoku *et al.*, 2013).

Conclusion

The study showed that the growth performance (weight gain, feed intake and feed conversion ration), linear body measurements (ear length and heart girth) and gestation length of pregnant rabbit does were regulated by feed restrictions, likewise, periods of restriction affected the

average feed intake during restriction and realimentation periods. Hence, growth rate, feed intake and linear body measurement of gestating rabbit does can be optimised via 15% feed restriction at 20-24 days of pregnancy.

References

- Akanno, E. C. and Ibe, S. N. 2006. Prediction of body weight of the domestic rabbit at different stages of growth using linear body measurements. *Nigerian Journal of Animal Production*, 33(1):3-8.
- Allen, C. E. 1993. New horizons in animal agriculture: future challenges for animal scientists. *Journal of Animal Science*, 57(2):16. <http://jas.fass.org/cgi/reprint/57/supplement2/16.pdf>.
- Barker, D. J. P. 1998. *Mothers, Babies and Health in Later Life*. Churchill Livingstone, London, UK.
- Biobaku, W.O. and Dosunmu, E.O. 2003. Growth response of rabbits fed graded levels of processed and dehulled sunflower seeds. *Nigerian Journal of Animal Production*, 30:179-184
- Boisot, P., Duperray, J., Dugenetais, X. and 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, September 7-10, Puebla, Mexico. 759-764.
- Brecchia, G., Menchetti, L., Cardinali, R., Polisca, A., Troisi, A., Maranesi, M. and Boiti, C. 2012. Effects of fasting during pregnancy in rabbit does. *Proceedings 10th World Rabbit Congress – September 3rd - 6th, Sharm El-Sheikh-Egypt*, 341- 345.
- Coudert, P. and Lebas, F. 1985.

- Production et morbidite de lapines reproductrices. Part I. Effects du rationnement alimentaire avant et pendant la première gestation. *Ann. Zootech.* 34(1):31–48
- Critser, D.J., Miller, P.S. and Lewis, A.J. 1995.** The effects of dietary protein concentration on compensatory growth in barrows and gilts. *Journal of Animal Science*, 73:3376-3383
- Dalle Zotte, A., H. Remignon, H. and Ouhayoun, J. 2005.** Effect of feed rationing during post-weaning growth on meat quality, muscle energy metabolism and fibre properties of biceps femoris muscle in the rabbit. *Meat Science*, 70:301–306.
- Donker, R.A., Denhartog, L.A., Brascamp, E.W., Merks, J.W.M., Noordewier, G.J. and Buiting, G.A.J. 1986.** Restriction of feed intake to optimize the overall performance and composition of pigs. *Livestock Production Science*, 15:353-365
- Fortun-Lamothe, L. 1997.** An effect of dietary fat on performance of rabbit does: A review. *World Rabbit Science*, 5(1):33-38.
- Fortun-Lamothe, L. 2006.** Energy balance and reproductive performance in rabbit does. *Animal Reproductive Science* 93:1-15
- G o o g l e E a r t h 2 0 1 6 .** <http://www.google.earth>
- Le roux, J.F., Mate, C. S., Szorad, I. and Colin, M 1998.** Replacement does: Growth and reproductive performance at first kindling. *Proceeding 10th Hungarian Rabbit Day, Kaposvar*, pp. 57-62.
- Manal, A.F., Yassein, S.A., Omaima, H.E. and Maghraby, N. 2004.** The effect of feed restriction as a management practice on productive and reproductive performance and maternal behaviour of rabbit does. *Journal Egyptian Veterinary Medicine Association*, 64 (6):279–298
- Manal, A.F., Tony, M.A. and Ezzo, O.H. 2010.** Feed restriction of pregnant nulliparous rabbit does: Consequences on reproductive performance and maternal behaviour. *Animal Reproduction Science*, 120:179-186
- Marty, M.S., Johnson, K.A. and Carney, E.W. 2003.** Effect of feed restriction on Hershberger and pubertal male assay endpoints. *Birth Defects Res. Part B Dev. Reproduction Toxicology*, 68:363–374
- Merck and Co. Inc. 2008.** Whitehouse Station, NJ USA, Published in Educational Partnership with Merial Ltd.
- Njoku, C.P., Sogunle, O.M., Adeyemi, O.A., Aina, A.B.J. and Oduguwa, O.O. 2012.** Response of growing pigs reared in humid tropical environment to different feeding frequencies. *International Journal of Applied Animal Science*, 1(4):102-107
- Njoku, C.P., Aina, A.B.J., Sogunle, O.M., Oduguwa, O.O., Adeyemi, O.A. and Ekunseitan, D.A. 2013.** Influence of feed quantity offered on linear body measurements, nutrient digestibility and back fat composition of finishing pigs. *The Pacific Journal of Science and Technology*, 14(1):387-396
- Obih, T.K.O. and Ekentem, B.U. 2010.** Performance and cost evaluation of substituting Bambara seed (*Vigna subterranean*) verdc offal for soybean meal in the diets of broiler

- starter chicks. *International Journal of Poultry Science*, 9(4): 349-357
- Onyimonyi, A.E., Ugwu, S.O.C. and Machebe, N.S. 2010.** Performance and linear measurements of growing pigs fed on basis of their body weight. *Pakistan Journal of Nutrition*, 9(1):57-59
- Owen, O.J., Alawa, J.P., Wekhe, S.N., Isirimah, N.O., Chukuigwe, E.C., Aniebo, A.O., Ngodigha, E.M. and Amakiri, A.O. 2008.** Incorporating poultry litter in animal feed: a solid waste management strategy. *Egyptian Journal of Animal Production*, 46(1): 63-68
- Rasmussen, K.M. 1998.** Effects of under and over nutrition on lactation in laboratory rats. *Journal of Nutrition*, 128(2):390–393.
- Robinson, J.S., Owens, J.A. and Owens, P.C. 1994.** Foetal growth and growth retardation: in *Textbook of Foetal Physiology*, G. D. Thorburn and R. Harding, Eds., pp. 83–94, Oxford University Press, New York, NY, USA.
- Rossdale, P. D. and Ousey, J.C. 2002.** Foetal programming for athletic performance in the Horse: Potential effects of IUGR. *Equine Veterinary Education*, 14:98–112.
- S.A.S. 2000.** SAS/STAT® User's guide (Version 8, 4th edition). SAS Institute; Cary, NC.
- Stoker, T.E., Laws, S.C., Guidici, D.L. and Cooper, R.L. 2000.** The effect of atrazine on puberty in male Wistar rats: An evaluation in the protocol for the assessment of pubertal development and thyroid function. *Toxicology Science*, 5:50-59
- Szendro, Z.S., Gyovai, M., Birone, N.E., Radnai, I., Nagy, I. and Matics, Z.S. 2001.** Effect of nutritional status of foetus, suckling and growing rabbits on their production between 3 and 13 weeks of age. *Allattnyeszt es Takarmanyozas*, 50(6):549-554.
- Tumova, E., Skrivanova, V. and Skrivan, M. 2003.** Effect of restricted feeding time and quantitative restriction in growing rabbits. *Arch. Geflogelkde*, 67:182–190.
- Tumova, E., Skrivanova, V., Zita, L., Skrivan, M. and Fucikova, A. 2004.** The effect of restriction on digestibility of nutrients, organ growth and blood picture in broiler rabbits. In: Proc. 8th World Rabbit Congress, September, 7-10th, Puebla, Mexico. 1008-1014
- Yakubu, A., Salako, A.E., Ladokun, A.O., Adua, M.M. and Bature, T.U.K. 2007.** Effects of feed restriction on performance, carcass yield, relative organ weights and some linear body measurements of weaner rabbits. *Pakistan Journal of Nutrition*, 6(4):391–396.

Received: 20th September, 2019

Accepted: 15th December, 2019