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FEED RESTRICTION REGIMENS EFFECTS ON GROWTH AND PHYSIOLOGICAL PERFORMANCE OF FATTENING RABBITS

By

Magda M. Fadel.[1], Kassem G. El -Iraqi [2], Rehab A. Ghandour[2*], and Manal A. Foad.[3]

[1]Master Postgraduate Student, Faculty of veterinary Medicine Cairo University.

[2,3] Dept.of Vet. Hygiene and Management. Faculty of veterinary Medicine, Cairo University.

[2*]Dept.of Physiology and Endocrinology, Faculty of Veterinary Medicine, Cairo University.

ABSTRACT

The present study was conducted to investigate the effect of post weaning feed restriction of fattening rabbits on their productive performance and physiology. A total of 48 weaned rabbits of 35 days age with average weight 633.59 ± 29.74 g were divided randomly into four groups “12 rabbits per group” as follows; the first group was the control group (C), rabbits were fed *ad-libitum* throughout the whole experimental period seven weeks post weaning, the remaining three groups (T1, T2 and T3) were the restricted groups, where the rabbits were restricted to 50 g feed/ head/day for one week (T1), two weeks (T2) and three weeks (T3). At the end of each restriction period rabbits of all groups were returned to *ad-libitum* feeding till the end of the experiment. The average live body weight, body weight gain, feed intake, FCR, mortality and morbidity were recorded weekly till the end of the experimental period for all groups.

The obtained results revealed that, feed restriction has a positive effect on growth performance, where T2 group recorded the highest marketing weight (1763 ± 36.27 g), followed by T3 group (1581 ± 29.4 g), then C group (1579.4 ±63.06 g), while the T1 group showed the lowest weight (1553 ± 27.18 g). Also, the FCR obtained was 4.24 ± 0.02 (T2) followed by 4.46 ± 0.02 (T3), 5.12 ± 0.1 (T1) while the highest FCR was recorded by control group (6.06 ± 0.05). Concerning blood biochemical parameters, it was observed that slight restriction decreased the blood glucose and improved the triglycerides and cholesterol levels in fattening rabbits compared with control group. Based on all obtained results, it could be concluded that fattening rabbits post weaning feed restriction “50 g / head daily” for 2-3 weeks has clear beneficial effects and can be used successfully as a good management tool in commercial rabbit farms.

Keywords:

Rabbit, feeding regimen, Fattening rabbit and rabbit performance.

***Corresponding Author:** Department of Veterinary Hygiene and Management, Cairo University, Giza Square- postal Code 12211.

INTRODUCTION

Feed accounts for the largest part of the production costs in rabbit's production and could reach up to 70% of total costs according to the investments.

Therefore, feed efficiency is a key criterion to improve the sustainability of the farm, both to improve economic balance and to reduce the environmental releases **Jentzer, (2008).**

The interest in studying feed restriction in rabbits recently increased as a means of reducing the cost of production, improving feed efficiency and standardizing growth curves in rabbits without affecting performance, carcass and meat traits **(Yakubu *et al.*, 2007 and Cavani *et al.*, 2009).**

Feed restriction has been used in the post-weaning period to, increasing diet digestibility, control the mortality due to digestive disorders, and however impair final live weights, slaughter yields, and body composition according to **(Tudela 2008, Gidenne *et al.* 2009a and Knudsen *et al.* 2014).** Feed restriction as nutritional issue affecting hematological and biochemical blood indices **(Addass *et al* .2012)**.

Some countries like France and Italy applied feed restriction post-weaning to reduce daily changes in feed intake and the possible negative consequences on digestive health and epizootic rabbit enteropathy occurrence **(Maertens and Gidenne, 2016).**

Therefore, the goal of the experiment was to study the effect of rabbit feed restriction for different times (one week, two weeks and three weeks) post-weaning on the growth performance and interpretation of the effects by blood biochemical indices of fattening rabbits.

MATERIAL AND METHODS

Rabbit Housing and Management:

This study was conducted at the Rabbit Research Unit, Department of Veterinary Hygiene and Management, Faculty of Veterinary Medicine, Cairo University. 48 weaned NZW rabbits of both sexes, at 35 days old and weighing about 633.59 ± 34.5 g were used in this study. Rabbits were housed in commercial battery consists of 12 wired cages (55 x 45 x 30 cm) 4 rabbits per cage. The system of rearing was semi-closed system, exposed to natural environmental temperature and photoperiod and ventilated by windows.

The temperature and humidity range during experiment were 16 °C to 25°C and 60 - 70%. Rabbits fed on a commercial pelleted rabbit diet with 16% crude protein, 13% crude fiber, and 2600 kcal/kg digestible energy according to the rabbits **NRC (1977).** The analyzed content of nutrients percent of the feed mixture is given in (Table 1).

Table (1): Ingredients (as labeled by their producing company) and chemical analysis of the experimental diets**.**

Ingredients	Percentage
Wheat bran	**27.50**
Clover hay meal (12%)	**24.50**
Soybean meal (44%)	**13.10**
Barley	**21.38**
Yellow corn	**7.00**
Molasses	**3.00**
Dicalcium phosphate	**1.71**
Limestone	**1.08**
Salt (NaCl)	**0.35**
Vit. and mineral mix	**0.30**
DL-methionine	**0.08**
Total	**100**

Analysis	Percentage
DE kcal/kg	**2500**
Crude protein %	**16.06**
Crude fiber%	**12.54**
Crude fat%	**2.50**
Calcium %	**1.23**
Total phosphorus%	**0.80**

Feed was given manually at 8:30 a.m. daily and water was available all-time ad libitum.

Experimental design:

Rabbits were randomly divided into four experimental groups (n=12 each), control group (C); the rabbits were fed ad-libitum throughout the whole experiment. Restricted group one (T1) were restricted to 50 g feed/ head /day for one-week, restricted group two (T2) were restricted to 50 g feed/ head /day for two weeks, restricted group three (T3) were restricted to 50 g feed/ head/day for three weeks. After the restriction time, all the groups were back to ad libitum feeding till the end of the experiment. The experimental period lasted for 7 weeks where animals of all groups were slaughtered.

Measuring Parameters:

The following parameters were recorded:

1-Productive performance parameters; individual initial weight of rabbits was recorded, then, feed intake, body weight, body weight gain, feed conversion ratio and mortality and morbidity rates were all recorded weekly. At the end of experiment, the same measurements were recorded again.

2. Blood biochemical indices; Five blood sample per each treatment was taken from the jugular vein. The blood samples were collected twice; at the end of the feed restriction in each group and at marketing. Samples were collected into tubes without anticoagulant agent; blood serum was separated by centrifugation 1,000 g for 10 min. and then stored at -20°C until analysis. Blood biochemical constituents including serum glucose was measured according to **Triender, (1996)**, total protein, albumin and globulin **Koller, (1984)**, serum triglyceride according to **Buccolo and David (1973)**, serum cholesterol **Young, (1995**), creatinine and uric acid according to **Burtis *et al.* (1999)** by using commercial kits(Bio diagnostic company) and using spectrophotometer Libra S22 (Biochrom Ltd., uk).

Statistical analysis:

The data were statistically analyzed by General Linear Model procedures (GLM) described in SAS User's Guide **(SAS, Institute, 2004).**

The differences among treatments means were subjected to significance by Duncan's Multiple Range-test.

RESULTS

Table (2): Effect of feed restriction on final performance parameters in different groups.

Groups Parameters	C	T1	T2	T3
Initial wt (g)	632.2±53.3	651.2±48.3	633.5±11.3	617.4±25.0
Final body weight (g)	1579.4±63.1 [b]	1553 ±127.1 [b]	1763.2±36.3 [a]	1581.2 ±29.4 [b]
Total weight gain (g)	947.2±80.5 [ab]	801.8±80.9 [b]	1129.5±30.7 [a]	963.8±37.2 [ab]
Total feed intake (g)	5745.1 ±84.6 [a]	4622.3±41.1 [b]	4788.6 ±22.2 [b]	4301.9 ±29.1 [b]
FCR	6.1 ±0.1 [c]	5.1 ±0.1 [b]	4.2 ±0.02 [a]	4.5 ±0.0 [ab]
Mortality rate (%)	8.3 ±0.2 [b]	8.3 ±0.2 [b]	0.0 ±0.0[a]	0.0 ±0.0 [a]
Morbidity rate (%)	0.0 ±0.0 [a]	8.3 ±0.2 [b]	0.0 ±0.0[a]	0.0 ±0.0[a]

C: rabbits were fed *ad libitum*, T1: rabbits were restricted to 50 g feed/ head daily for one week, T2: rabbits were restricted to 50 g feed/ head daily for two weeks, T3: rabbits were restricted to 50 g feed/ head daily for three weeks,

a, b, c: Different letters within the same row were significantly different at p≤ 0.05 between the groups.

Table (3): The blood biochemical indices at the end of restriction in different groups.

Groups Parmeters	C	T1	T2	T3
Blood glucose(mmol /l)	6.8 ±0.76 [a]	6.72 ± 7.5 [a]	5.9 ± 1.45 [b]	4.75 ± 1.32 [c]
Total protein (g/dl)	4.57 ± 0.23 [a]	3.52 ± 0.43 [b]	3.79 ± 0.57 [b]	4.3 ± 0.57 [a]
Albumin (g/dl)	2.86 ± 0.38 [b]	2.97 ± 0.016 [b]	2.43 ± 0.26 [b]	3.5 ± 0.25 [a]
Globulin (g/dl)	1.71 ± 0.28 [a]	0.605 ± 0.40 [b]	1.39 ± 0.11 [a]	0.8 ± 0.32 [b]
Triglycerides(mg/dl)	34.00 ± 3.36 [a]	33.005 ± 3.76 [a]	32.9 ± 0.88 [b]	22.87 ± 0.4 [c]
Cholesterol (mg/dl)	57.54 ± 11.17 [a]	58.93 ± 3.7 [a]	46.2 ± 1.15 [b]	45.53 ± 0.72 [b]
Creatinine (mmol/l)	3.32 ± 2.18 [c]	6.33 ± 3.8 [a]	4.0 ± 0.28 [b]	4.29 ± 0.28 [b]
Uric acid (mmol/l)	1.13 ± 0.45 [b]	1.8 ± 0.06 [b]	3.57 ± 0.34 [a]	3.335 ± 0.19 [a]
GOT (mmol/l)	59 ± 15.33 [a]	55.5 ± 0.00 [b]	49.5 ± 1.15 [c]	25.25 ± 6.2 [d]
GPT (mmol/l)	7.33 ±1.33 [a]	8.0 ± 1.63 [a]	4.0 ± 0.57 [c]	6.0 ± 0.0 [b]

C: rabbits were fed *ad libitum*, T1: rabbits were restricted to 50 g feed/ head daily for one week, T2: rabbits were restricted to 50 g feed/ head daily for two weeks, T3: rabbits were restricted to 50 g feed/ head daily for three weeks,

a, b, c: Different letters within the same row were significantly different at p≤ 0.05.

Table (4): Blood biochemical indices at marketing in different groups.

Groups Parameters	C	T1	T2	T3
Blood glucose (mmol/l)	**7 .25 ± 0.33 [a]**	**7.53 ± 0.405 [a]**	**6 .64 ± 1.15 [b]**	**6 .41 ± 0.1 [b]**
Total protein (g/dl)	**3.40 ± 0.06 [d]**	**5.17 ± 0.36 [c]**	**6.41 ± 1.15 [b]**	**8.65 ± 2.35 [a]**
Albumin (g/dl)	**2.88 ± 0.47 [b]**	**3.96 ± 0.17 [a]**	**3.49 ± 0.05 [a]**	**3.17 ± 0.86 [a]**
Globulin (g/dl)	**1.71 ± 0.3 [c]**	**1.87 ± 0.72 [c]**	**2.92 ± 0.115 [b]**	**3.56 ± 0.96 [a]**
Triglycerides (mg/dl)	**37.08 ± 12.8 [b]**	**32.77 ± 7.11 [c]**	**26.22 ± 0.11 [d]**	**40.16 ± 28.82 [a]**
Cholesterol (mg/dl)	**62.7 ± 0.77 [b]**	**66.4 ± 10.88 [a]**	**59.9 ± 5.19 [c]**	**56.5 ± 5.4 [c]**
Creatinine (mmol/l)	**5.21 ± 0.09 [a]**	**2.44 ± 0.36 [b]**	**2.29 ± 0.2 [b]**	**2.66 ± 0.0 [b]**
Uric acid (mmol/l)	**1.32 ± 0.38 [b]**	**2.49 ± 0.55 [a]**	**2.33 ± 0.17[a]**	**2.58 ± 7.08 [a]**
GOT (mmol/l)	**54 ± 0.86 [c]**	**89 ± 0.0 [a]**	**88.66 ± 2.6 [a]**	**69.25 ± 11.4 [b]**
GPT (mmol/l)	**6.00 ± 0.0 [c]**	**9.16 ± 3.002 [b]**	**6.00 ± 0.57 [c]**	**10.25 ± 2.45 [a]**

C: rabbits were fed *ad libitum*, T1: rabbits were restricted to 50 g feed/ head daily for one week, T2: rabbits were restricted to 50 g feed/ head daily for two weeks, T3: rabbits were restricted to 50 g feed/ head daily for three weeks,

a, b, c: Different letter within the same row means significantly differ at p≤ 0.05 between the groups.

DISCUSSION

Live body weight (LBW), body weight gain (BWG) and feed conversion (FC):

A detailed evaluation of final growth performance parameters "LBW, BWG, FI, FCR and mortality %" showed that, the restriction followed by re-alimentation program adopted in this experiment increased the final LBW, BWG of T2 and T3 than C groups "inspite of similarity of their initial LBW" where the total LBW and BWG during the whole period was 1763.2±36.27 and 1129.45±30.7 (T2), 1581.25 ±29.4 and 963.8±37.2 (T3) vs 1579.40±63.06 and 947.2±80.5 in control rabbits. However, no significant differences were recorded between control group and T1 which acheived 1553 ±127.1 and 801.83±80.9 for LBW and BWG respectively (Table 2).

These results agreed with **Martignon *et al.*,(2010) and Gidenne *et al.*,(2009b)**, in which they concluded that, the impact of rabbit intake limitation on weight gain is generally more severe at the beginning of the restriction period and when animals are fed *ad libitum* again, a compensatory growth was always found and the weight gain could be 20 to 30% over the weight gain of control and could reach very high value.

In addition, **Tumova *et al.* (2016)** suggested that, the most criteria for compensatory growth may be due to better nutrient digestibility during restriction and at the beginning of re-alimentation process.

Interestingly, this higher BWG of restricted groups was associated with significantly lower FI of these restricted rabbits in comparison with the control group where the total FI throughout the entire experimental period was 5745.15 ±84.58 for rabbits fed *ad libitum* (C group) while it decreased to 4622.31±41.05,4788.63±22.2,4301.85±29.14 in those of T1,T2,T3 respectively (Table 2).

These results agree with **Gidenne and Lebas (2006)** who stated that rabbit cannot over eat even after hard restriction because its stomach volume cannot be enlarged at once quickly, but adapted gradually to numerous larger meals.

On contrary with these results, **Knudsen *et al.* (2014)** observed that, the compensatory growth that occurred during the freely ad libtum feeding, was associated with increased feed intake and related to overfeeding.

The increased BWG together with the reduced FI of restricted groups ultimately improved the total FCR ratio of T1, T2, T3 groups in comparison with C group to be 5.12 ±0.1, 4.24 ±0.02, 4.46 ±0.02 Vs 6.06 ±0.05 in the three restricted T1, T2, T3 Vs control groups respectively (Table 2).

Similar results for the favorable effect of intake limitation on FCR were obtained by several authors using different restriction strategies **(Maertens and Peeters,1988; Szendro *et al*., 1989: Perrier and Ouhayoun, 1996; Perrier, 1998, Gidenne *et al.*, 2009a).**

Mortality and Morbidity:

The effect of feed restriction has been studied before on growing rabbits after weaning with different intensities **(makovicky *et al.*, 2014)**.

It was applied usually for different periods after weaning or as a restriction percentage from the free intake. Feed restriction was assumed to reduce the incidence of enteropathies in growing rabbits that may lead to animal losses **(Di Meo *et al.*, 2007).**

Data obtained in this study revealed that, mortality cases were noticed in rabbits of C and T1 groups (8.33% for each group), while morbidity was recorded only in T1 group (8.33%).

However, neither morbidity nor mortality cases were recorded at all for T2 and T3 groups throughout the whole experimental period (Table 2).

This was matched with the results obtained by **Gidenne *et al*. (2009a)** who recorded that, the mortality and morbidity in restricted animals, for a minimum level of intake reduction of 20%, almost reduced to 50 %.

Both morbidity and mortality which occurred in C and T1 groups, in our experiment, were always caused by digestive disorders, namely diarrhea and or caecal impaction. Moreover, they occurred only during the early post weaning period not during the finishing one (last 3 weeks).

Contrarily, for C and T1 groups, mortality and morbidity cases occurred only during the post weaning period not during the finishing one.

Generally, the post-weaning period corresponds to an increased sensitivity to digestive troubles, with a higher mortality and morbidity cases compared to the finishing period, as reported in previous studies **(Giddenne *et al.*, 2004 and 2005).**

The results of the present study illustrated a favorable impact of feed restriction“50-70% of ad-libitum” for 2 or 3 weeks on the digestive health of young rabbits. As noticed in absent mortality and morbidity in T2 and T3 groups. These results agree with that stated by **(Gidenne *et al*., 2012)** who found the longer restriction time for 2 or 3 weeks, reduced mortality and morbidity in rabbits specially from the digestive troubles.

However, the mortality recorded in T1 group is nearly similar to the finding of **(Ebeid *et al.* 2012)** who illustrated that a short feed restriction had no tendency to improve the mortality of the animals.

Generally, final performance results obtained specially “higher BWG, reduced FCR" in this experiment stressed the economic importance of such feeding strategy (2-3 weeks restriction followed by 3 weeks ad libitum feeding) for the growing fattening rabbits reduces feeding costs without impairing final LBW, BWG together with improvement of survival% and reducing morbidity.

<u>Blood biochemical parameters:</u>

We can depend on the biochemical blood characteristics as an important measurement to evaluate the health status of animals and the level of their metabolism. From (Tables 3,4), there was significant difference in blood parameters results at $P \leq 0.05$.

The blood glucose concentrations at the end of restriction period was decreased with the increasing restriction period, this may be related to the intake quantity in restricted animals (50 g /head/ days) that is about 20-50 % less than *ad libitum* group. At marketing age, the blood glucose concentrations in T2, T3 groups still lower than control group. While no significant differences between control group and one-week restriction.

These results agree with **Rommers *et al*. (2004)** who concluded that glucose concentration decreased during the period of feed restriction in rabbit does, and disagree with **Van Harten and Cardoso (2010)** who found that, the glucose concentration was not affected by feed restriction in the New Zealand rabbit.

Theconcentration of totalprotein,albumen, globulin triglyceride and cholesterol concentrations were within the physiological range described by **Archetti *et al.* (2008) and Özkan *et al.* (2012)**. And from our results it was clear that the restriction lowering these blood biochemical indices during the restriction period, these results are in accordance with the report of **Van Harten and Cardoso (2010)** who stated that feed restriction reduced significantly triglycerides, non-esterified fatty acid and induced a higher lipidic depletion in these animals. Also, **Rajman *et al*. (2006)** confirmed that feed restriction decreased plasma concenk2trations of total lipids, TG, cholesterol, high density lipids, total protein and albumin.

At marketing the total protein, albumen, globulin, triglyceride and cholesterol concentrations were increased in restricted groups than control one,that,may be related to the re-alimentation of restriction,rabbits feed ad-libitum and begin to correct the blood biochemical parameters such as in case of compensatory growth like results obtained by **Gidenne *et al*., (2011)** as the intensity of compensatory growth is related to the intensity of the restriction. The same in blood protein albumen and globulin level increased at marketing with increasing the restriction period. This result disagreed with **Ebeid *et al* (2012)** who referred that there is no significant effect to restriction in plasma total proteins.

On the other hand, a significant difference recorded between different groups in the kidney function parameters including creatinine,uric acid, GOT, and GPT, generally we can conclude from our results that restriction achieved a slight increase in serum creatinine and uric acid that was may be related to decreased glomerular filtration rate associated with decreased renal blood flow and circulating blood volume. But the decrease creatinine in some restricted groups compared to control indicated that feed restriction improves kidney function and significant decrease in GOT and GPT the improvement of the liver function these results disagree with results obtained in broiler by **Attia *et al.*, (2017)** that Hepatic leakage (AST and ALT enzymes), muscle catabolism (creatinine) (end of restriction period) and (end of re-alimentation period) were not affected by FR regimen.

CONCLUSION

From the results obtained, it could be concluded that, post-weaning intake restriction of fattening rabbits *"50 g feed/head daily"* for 2-3 weeks followed by a period of ad libitum feeding for another 3-4 weeks increased weight gain, reduced total feed intake, enhance early marketing and improved feed conversion ratio that lead to better farm economics.

At last, such feeding strategy is a good farm practice that could be recommended for weaned rabbit feeding management as it represents a triple benefit in terms of growth performance, feed costs and lower levels of young losses.

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