Egypt. Poult. Sci. Vol. (41) (III): (565-578)(2021) **(2106-1173)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF FEED RESTRICTION REGIMEN ON PRODUCTIVE PERFORMANCE AND ECONOMICAL EFFICIENCY OF WEANING NZW RABBITS

Sara Khalil Sherif

Poult. Prod. Dep., Fac. of Agric., Mansoura Uni., Egypt

Corresponding author: Sara Khalil Sherif, E-mail: sarasherif349@yahoo.com

Received: 26/06/2021 Accepted: 05 /09/2021

ABSTRACT: This experiment aimed to study the effects of feed restriction (FR) on weaning New Zealand White Rabbit's growth performance. Seventy-five unsexed rabbits (5 weeks of age) were divided to five experimental treatments with five equal replications. Feed restriction program was used in the first two weeks (5-7 weeks old) after weaning as follows; the first treatment (control) was free fed the experimental diet. While other treatments (2 to 5) were fed restricted diets at levels of 10, 20, 30 and 40%, respectively from the free feeding of the control. All rabbits were free fed grower diet from ٨ to 12 weeks of age. During this trial rabbit growth performance were evaluated, carcass traits, mortality rate and economic efficiency. Some blood parameters in rabbit serum were also determined. The obtained results illustrated that final weight of rabbit was recovered and feed conversion ratio was improved by FR. FR program did not affect carcass traits. Serum blood parameters were not affected by feed restriction. It could be concluded that feed restriction at levels of 30 or 40% during the first two weeks after weaning had beneficial effects on rabbit growth performance, improved feed conversion and economic efficiency and decreasing mortality rate.

Keywords: NZW Rabbit, feed restriction, growth performance, carcass, mortality ratio

INTRODUCTION

The rapid growth rate in early life of rabbit is accompanied by some problems, such as increased body fat deposition, high mortality, metabolic problems. Using FR for weanling rabbits may be improve feed utilization (Gidenne et al., 2009 and Gidenne et al., 2012), to induce compensatory growth. (Foubert et al., 2008). Also, to decrease carcass fat, and improve nutrients utilization during restricted feeding period (Di Meo et al., 2007).

In commercial farms, growing rabbits are usually fed *ad libitum* (Maertens, 2009). However, feeding can be restricted during the post-weaning period to improve feeding efficiency and standardize growth rate in rabbits with a different intake level or to control the digestive disorders (Gidenne et al., 2009, 2011 and Maertens and Gidenne, 2016). FR is a good strategy for growing rabbit production, as it can lower the cost of feeding and decrease health disorders (Foubert *et al.,* 2008).

Generally, the post-weaning period corresponds to an increased sensitivity to digestive troubles, with a higher mortality comparing to the finishing period (Gidenne *et al.,* 2005). Gidenne *et al.* (2009) found that impair final live weights (FBW) and slaughter yields by restricted feed (20% to 40%) for three or four-weeks post-weaning. Free feeding was used for growing rabbits to maximize their production (Maertens, 2010). FR is an animal production strategy with the purpose of reducing feed intake to reduce the feeding costs and the incidence of gastrointestinal pathologies (Alabiso *et al.,* 2017), especially after stress time, such as weaning (Gallois *et al.,* 2008). Recently, Birolo *et al.,* (2016) reported that restriction program (93% of *ad libitum*) during the first period improved rabbit health status in the fattening sector without negative effects on growth performance or carcass traits.

Economic efficiency (EE) can be improved with decreasing feeding cost through using strategy of FR which gave a beneficial effect of feeding utilization and weight gain. Therefore, the objective of the present study was to investigate the effect of feed restriction during the first two weeks after weaning on growth performance, economic efficiency, mortality rate of growing NZW rabbits, carcass yield and blood parameters.

MATERIALS AND METHODS

Experimental design

The current experiment was carried out at the Rabbit Research Unit, Faculty of Agriculture, Mansoura University, Egypt, during October and November, 2020. Seventy-five NZW weaned rabbits (5-week-old) with a mean weight of 652±g. The rabbits were divided to five experimental treatments (T1, T2, T3, T4 and T5), each with five replicates (Table 1). Three rabbits were kept in each cage (45 × 45 × 35 cm) and fed pelleted commercial grower diets (CP, 18% ; DE, 2500 kcal/kg) formulated to meet recommended nutrient requirements of rabbits according to NRC (1977). In the first and second week in this trail, the rabbits in T1 were free fed the experimental diet. However, animals in other treatments (T2, T3, T4 and T5) were fed restricted diets at levels of 10, 20, 30 and 40%, respectively of the free feeding of T1. All rabbits were free fed the grower diet from 8 to 12-week-old.

Growth performance

Weekly body weight (BW), daily feed intake (DFI) and weight gain (TBG) were recorded whereas feed conversion ratio

(FCR) were weekly calculated and during whole experimental period (5-12 weeks of age) was also, calculated. Mortality rate (MR%) of rabbits was also recorded during the trial period. Economic efficiency (EE) of growing NZW rabbits was calculated; EE = [(Net return) / feed cost) × 100]. Where the price of one kg rabbit = 40 EGP and the cost of one kg diet = 6.0 EGP.

Carcass traits

Five rabbits' treatment at 12-week-old were chosen randomly for slaughter test after 12 hrs. without feeding before slaughtering. LBW of rabbits were recorded, and slaughter test was performed to calculate carcass yield and components percentage of LBW.

Blood parameters

At slaughtering, five rabbits from each treatment were chosen to collect five blood samples. The serum was separated by centrifugation process (3000 rpm through 20 minutes). Serum blood parameters of total protein (TP); Henry (1964), albumin (Alb); Doumas *et al*. (1971) were determined, Globulin (Glb) was determined by subtracting Alb from TP. Total lipids (TL) by the method of Chabrol and Charonnat (1973); triglycerides (TG); Tietz (1995), cholesterol (TC); Allain et al. (1974) and high-density lipoprotein cholesterol (HDL) Sawle *et al*. (2002) were determined using diagnostic kits. Serum concentration of low-density lipoprotein-cholesterol (LDL) was also estimated according Friedewald *et al*. (1972). The activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were estimated by diagnostic commercial kits (Reitman and Frankel, 1957). Total antioxidant capacity (TAC), malondialdehyde (MDA) and superoxide dismutase (SOD) were determined according to Koracevic *et al*. (2001), Mihara and Uchiyama (1978) and Yi-Sun *et al.,* (1988), respectively. Corticosterone (Cort.) concentration in blood serum was determined (Jezová *et al*., 1994).

Statistical analysis

One-way analysis of variance using Statgraphics (Rockville, 1991) was used to analyze the obtained data. The significance level of 0.05 was used to consider the differences among treatments were significant (Duncan, 1955). The following statistical model was used: $Yij = \mu + Fi + eij$. Where: Yij = observed traits; μ = the overall mean; Fi = effect of feed restriction; eij = experimental random error.

RESULTS AND DISCUSSION

Growth performance

Table 1 showed a significant (P< 0.01) impair in LBW of rabbits fed restricted diets during 6^{th}, 7^{th}, 8^{th} weeks of ages. Where, the values of LBW in T4, T5 were lower compared with the other treatments. However, LBW was not significantly affected by FR at 9^{th} to 12^{th} weeks of age. Daily gain (ADG) of rabbits fed restricted diets was decreased significantly during 6^{th} – 7^{th} weeks of age. Through the 6^{th} week the values of ADG in T1, T2, T3 were high comparing with T4 and T5. However, during the 7^{th} week, the values of ADG in T4, T5 were lower compared with the other treatments (T1, T2 and T3). Whereas ADG was significantly similar for all experimental treatments during the period from 8^{th} to 12^{th} weeks of age. Disappear of significant differences in weight gain among the experimental treatments during the period from 8 to 12 weeks of age may be due to compensatory growth and better feed utilization and the start of free feeding in rabbits fed restricted diets.

Our results agree with those of Fadel *et al.* (2019) who showed that FR to 50g feed/ rabbit/day during two or three weeks after weaning resulted in increased marketing weight of rabbits compared with the control group. Tumova *et al.* (2016) observed that compensatory growth due to better digestion nutrients during restricted feed and at the start of free feeding. The results of Knudsen *et al.* (2014) showed improvement in rabbit FBW by FR post-weaning period due to compensatory in growth associated with increased feed intake (FI). Yassein *et al.* (2011) showed that BW of rabbits fed restricted diet (60% of free feeding) significantly lower than the control at 49 days old. They mentioned that rabbits had a significant compensatory growth after FR period. Also, Martignon *et al.* (2010) mentioned that FR caused to compensate in weight gain by about 20 to 30% more than the control treatment. Foubert *et al.* (2008) reported that rabbits subjected to FR had higher FBW due to compensatory growth.

In these respects, Birolo *et al.* (2017) found that growth rate of rabbits did not affect by rabbits exposed to FR. Also, El-Speiy *et al.* (2015) illustrated the lowest rabbits TBG due to subjected rabbits fed restricted diet (50 g diet /d/ rabbit) during the 5^{th} to the 6^{th} and (90 g diet/d /rabbit) during the 8^{th} to 9^{th} weeks compared with the other groups. Uhlířová *et al.,* (2015) reported that FBW decreased due to rabbits subjected to FR. Also, Gidenne *et al.* (2009) observed that FR for rabbits caused to an improvement in weight gain and marketing weight. Bergaoui *et al.* (2008) found that rabbits subjected to FR (85% and 70% of free feed) had lower BW compared to the control group. Di Meo *et al.,* (2007) found that rabbits exposed to FR decreased marketing weight. Tumova *et al.* (2003) demonstrated that FBW of rabbits did not affect by FR.

In Table (2), results showed significant increase in FI of the control comparing with fed restricted diet groups during the periods of 6^{th} and 7^{th} weeks of age. FI was not significant differ during the experimental periods of 8^{th}, 9^{th}, 11^{th} and 12^{th} weeks of age by the experimental treatments. During the 10^{th} week of age rabbits fed restricted diet at level of 40% (T5) consumed less feed comparing with the control group T2 and T3. During the whole period of study (5-12 weeks of age) rabbits of the control group consumed more feed ($P \leq 0.05$) comparing with rabbit in T4 and T5 without differences between the control group and T2 or T3.

Data in Table 2 showed that FCR improved by FR treatments during the periods of 5^{th} to 10^{th} weeks of age and the whole period of study (5-12 weeks of study). While FCR was not differed among the experimental treatments at the other periods of study. During the whole period of study, the control group (T1) achieved the worth FCR comparing with T3, T4 and T5, but not differ with T2. The obtained results revealed good performance for feed restriction groups regarding to final body weight, weight gain and feed conversion, may be due to the compensatory growth after restriction period.

In agreement with our results, Abou-Kassem (2017) found that FI of NZW rabbits in control group increased compared with other groups subjected to FR (50 -75-100-125 g/d/rabbit for two weeks) during all experimental periods. Also, El-Speiy *et al.* (2015) found that rabbits fed restricted diet (50g/rabbit/day) consumed less feed comparing with control rabbits. However, improved feed utilization. On the other hand, Yassein *et al.* (2011) illustrated that FI and FCR of growing rabbits did not significantly influence by restricted feeding.

Fadel *et al.* (2019) observed that FR (50 g feed/head/day) significantly improved FCR comparing with the control counterparts. Birolo *et al.* (2017) found that FCR of growing rabbits improved by rabbits subjected to 20% FR. Gidenne *et al.* (2009), Gidenne and Feugier (2009) Gidenne *et al.* (2012) found that rabbit subjected to FR post weaning achieved best feed conversion ratio FCR and improved marketing weight of rabbits. Also, Cavani *et al.* (2009) reported that feed efficiency of rabbits exposed to FR was improved. In this meaning, Di Meo *et al.* (2007) found that digestion coefficient of nutrients was improved leading to improvement in FCR for rabbits exposed to FR.

However, Alabiso *et al.* (2017) demonstrated that restricted feeding for three weeks post weaning resulted in reducing FI and FCR of fattening rabbits. Birolo *et al.* (2016) showed that FR post weaning reduced FI for growing rabbits. Also, Maertens and Gidenne (2016) found that FR (20-40%) led to low DFI and improve FCR for growing rabbits. In this meaning, Romero *et al.* (2010) showed that restricted feed (fed 8 hours daily at 2 weeks after weaning) for growing rabbits decreased FI, however FCR did not improve in all experimental period. Tumova *et al.* (2003) found that FCR of growing rabbits was not affected by FR.

Mortality and economic efficiency

Mortality ratio (MR, %), viability (V %) percentages and economic efficiency (EE) for rabbits subjected to feed restriction were significantly improved (Table 3). MR (%) value was high for control group compared with other groups of rabbits subjected to FR. EE values were significantly high in T5 (40% FR) followed by values with T4, T3, T2, and T1 (control group), respectively.

The results are in harmony agreement with Abou-Kassem (2017) who showed that MR (%) of rabbits did not significantly affect by FR during experimental periods and EE was improved because of FR on carcass weight improvement. Mousa *et al.* (2017) found that rabbits subjected to FR had lower MR (11%) than the control group (15%). El-Speiy *et al.* (2015) observed that MR of rabbits reduced by FR (50 g/d/rabbit) compared to the control and improved EE. Gidenne *et al.* (2012) reported that MR of growing rabbits decreased with FR (2 or 3 weeks of growing period). Romero *et al.* (2010) observed that rabbits exposed to FR (fed 8 hours daily at 2 weeks after weaning) had low MR because of FR reduced bloated abdomen, relatively low body weight, diarrhea. Gidenne *et al.* (2009) indicated that rabbits subjected to FR decreased MR compared with control rabbits. On the other hand, Ebeid *et al.* (2012) found that MR of fattening rabbits did not affected by FR.

The current results partially agree with the finding of Oliveira *et al.* (2012) who found that FR had best EE of growing rabbit compared with the control group. Also, Gidenne *et al.* (2003) reported that weaning rabbits fed restricted diets reduced feeding cost and decreased the health risk which leads to the beneficial effect on EE.

Carcass traits

In Table 4, carcass traits of rabbits at the end of the experiment were not significantly affected by FR.

Confirming to our results, Birolo *et al.* (2016 & 2017) found that carcass parts percentage of growing rabbits did not affect by FR. Cavani *et al.* (2009)

reported that carcass traits did not affect by FR of rabbits. Boisot *et al.* (2004) showed that rabbits fed restriction did not affected of carcass traits percentage. Tumova *et al.* (2003 and 2006) reported that carcass weight of rabbits did not affect by FR, but renal fat was decreased.

On the other hand, Abou-Kassem (2017) showed that rabbits carcass weight improved by restricted feeding of rabbits. Regarding carcass traits, Gidenne *et al.* (2009) observed that rabbits fed restriction (20%) had significantly positively affected on carcass percentage compared with the control group. However, Tumova *et al.* (2004) found that rabbits feed restriction had improved carcass weight and decreased fat deposition.

Oliveira *et al.* (2012), and Alabiso *et al.* (2017) found decreased carcass yield for rabbits subjected to feed restriction. Also, El-Speiy *et al.* (2015) observed that rabbits subjected to restricted feeding (50 g/d/rabbit) at long time had significantly decreased carcass weight percentages compared with the other groups. Uhlířová *et al.* (2015) reported that rabbits carcass weight impaired due to exposed to FR and enhance digestive tract weight and decreased growth rate. Bergaoui *et al.* (2008) found that rabbits carcass weight percentage had significantly decreased by restricted feeding compared to the control group.

Serum blood parameters

The obtained results revealed insignificant effect in all serum blood parameters with exception of corticosterone which increased significantly due to FR (Table, 5). The absence of significance in blood parameters revealed that good health status of the experimental rabbit groups.

Regarding to our results, Abou-Kassem (2017) observed that blood parameters of (TP, Alb, Glb, AST and ALT) of growing rabbits did not affect by FR. Ebeid *et al.* (2012) found that there is no significant effect to FR in plasma TP. Nafeaa *et al.* (2011) observed that rabbits fed restricted diet had no significant effect in blood traits expect serum TP was significantly decreased by FR. Also, Van Harten and Cardoso (2010) observed that, the blood glucose was not affected by restricted feeding in the NZW. Tumove *et al.* (2007) reported that rabbits exposed to FR did not significantly affect in blood parameters.

On the other hand, Fadel *et al.* (2019) observed that slight restriction (50 g feed/head/day) reduced blood glucose and improved the triglycerides and cholesterol levels in growing rabbits compared with control group. Also, El-Speiy *et al.* (2015) observed that rabbits exposed to restricted feeding (50 g/d/rabbit) had significantly decreased TL, TC, TP and TG comparing with the control rabbit. Gidenne *et al.*, (2011) illustrated that rabbit blood concentration of TP, Alb, Glb, TG and TC concentrations were increased in restricted groups than control rabbits**.**

CONCLUSION

It could be concluded that feed restriction at levels of 30 or 40% during the first two weeks after weaning had beneficial effects on rabbit growth performance, improved feed conversion and economic efficiency and decreasing mortality rate.

Table (1): Effects of feed restriction on weekly body weight (g) and daily body weight gain (g) of NZW rabbits

Treatments	**Weekly Body Weight**							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
T1	651.0	822.2[a]	997.2[a]	1166.2[a]	1352.5	1574.2	1773.0	1975.3
T2	655.3	809.3[a]	969.8[b]	1165.5[a]	1368.0	1573.3	1767.3	1971.3
T3	651.3	809.3[a]	954.3[b]	1137.7[ab]	1341.7	1546.7	1768.0	1970.0
T4	651.7	784.0[b]	910.7[c]	1095.0[b]	1311.0	1518.8	1722.7	1941.7
T5	652.0	783.3[b]	898.0[c]	1099.7[b]	1300.3	1492.3	1696.3	1928.0
SEM	2.13	6.89	8.45	16.06	20.24	21.33	29.08	32.04
Significance	NS	**	**	**	NS	NS	NS	NS
Treatments	**Daily body weight gain (Age intervals; wks)**							
	5-6	**6-7**	**7-8**	**8-9**	**9-10**	**10-11**	**11-12**	**5-12**
T1	24.50[a]	24.92[a]	24.14	26.62	31.67	28.40	28.90	28.18
T2	22.00[a]	22.92[ab]	27.95	28.93	29.33	27.71	29.14	28.00
T3	22.57[a]	20.71[b]	26.19	29.14	29.29	31.62	28.86	28.06
T4	18.90[b]	18.10[c]	26.33	30.86	29.69	29.12	31.29	27.45
T5	18.76[b]	16.38[c]	28.81	28.67	27.43	29.14	33.10	27.15
SEM	0.88	0.76	1.90	1.32	1.63	1.48	2.33	0.68
Significance	**	**	NS	NS	NS	NS	NS	NS

a-c: Means within column with different superscripts are significantly different.
SEM = Standard error of the means; NS=Not significant; **= Significant at P≤0.01

Table (2): Effects of feed restriction on daily feed intake (g) and feed conversion ratio of NZW rabbits

Treatments	**Daily feed intake (Age intervals; wks.)**							
	5-6	**6-7**	**7-8**	**8-9**	**9-10**	**10-11**	**11-12**	**5-12**
T1	50[a]	65[a]	71.33	88.88	108.31[a]	122.05	113.86	88.49[a]
T2	45[b]	58.5[b]	79.45	86.64	106.98[a]	118.95	109.14	86.38[ab]
T3	40[c]	52[c]	74.48	90.90	101.48[a]	115.38	105.95	82.88[abc]
T4	35[d]	45.5[d]	73.83	85.19	94.21[ab]	115.45	111.29	80.07[bc]
T5	30[e]	39[e]	79.43	81.1	82.24[b]	109.05	107.24	75.44[c]
SEM	0.0	0.0	4.48	5.39	5.32	6.87	7.12	2.53
Significance	**	**	NS	NS	*	NS	NS	*
Treatments	**Feed conversion ratio (Age intervals; wks)**							
	5-6	6-7	7-8	8-9	9-10	10-11	11-12	5-12
T1	2.05[c]	2.61	3.02	3.38	3.44	4.29[b]	4.12	3.14[c]
T2	2.05[c]	2.57	2.83	2.99	3.66	4.29[b]	3.74	3.08[bc]
T3	1.78[ab]	2.53	2.85	3.16	3.48	3.67[a]	3.76	2.96[ab]
T4	1.87[bc]	2.54	2.84	2.78	3.20	3.96[ab]	3.57	2.92[ab]
T5	1.62[a]	2.39	2.75	2.83	3.05	3.75[a]	3.25	2.78[a]
SEM	0.08	0.098	0.12	0.22	0.20	0.13	0.29	0.06
Significance	**	NS	NS	NS	NS	**	NS	**

Different superscripts in the same column indicate significant difference between means at $P \leq 0.05$.
SEM = Standard error of the means; NS=Not significant; *=Significant at $P \leq 0.05$; **= Significant at $P \leq 0.01$

Table (3): Effects of feed restriction on mortality, viability and economic efficiency of feed

Treatments	**Mortality (%)**	**Viability (%)**	**Economic efficiency (%)**
T1	33.3[a]	66.67[b]	103.8[c]
T2	13.33[b]	86.67[a]	107.9[bc]
T3	0.0[b]	100[a]	116.5[bc]
T4	6.67[b]	93.33[a]	119.5[ab]
T5	0.0[b]	100[a]	130.5[a]
SEM	6.67	6.67	4.45
Significance	*	*	**

Different superscripts in the same column indicate significant difference between means at $P \leq 0.05$.
*=Significant at $P \leq 0.05$; **= Significant at $P \leq 0.01$

Table (4): Effects of feed restriction on carcass traits of NZW rabbits

Treatments	Live weight (g)	Carcass %	Feet+fur %	Kidneys (%)	Heart (%)	Liver (%)	Giblet (%)	Total edible parts (%)	Non-edible parts (%)
T1	1934	52.26	18.21	0.54	0.28	4.01	4.83	57.09	42.91
T2	1944	52.81	18.05	0.56	0.29	3.85	4.69	57.51	42.49
T3	2012	54.02	17.75	0.58	0.29	3.62	4.48	58.50	41.50
T4	1955	52.50	19.12	0.58	0.30	3.60	4.48	56.98	43.02
T5	1951	53.57	18.96	0.58	0.29	3.90	4.76	58.34	41.66
SEM	32.89	0.59	0.41	0.03	0.01	0.22	0.23	0.62	0.62
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Not significant

Table (5): Effects of feed restriction on serum blood parameters of NZW rabbits

Serum Blood parameters	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
TP (g/dl)	5.84	5.48	5.46	5.34	5.71	0.19	NS
Alb (g/dl)	2.65	2.55	2.71	2.70	2.65	0.16	NS
Glb (g/dl)	3.19	2.93	2.75	2.64	3.07	0.25	NS
TL (g/l)	6.06	5.97	5.25	5.98	6.43	0.43	NS
TG (mg/dl)	181.3	173.7	179.6	178.1	184.4	5.69	NS
TC (mg/dl)	210.9	205.4	212.4	208.2	210.6	6.44	NS
HDL (mg/dl)	39.01	42.28	38.26	41.44	41.66	2.67	NS
LDL (mg/dl)	90.48	86.88	94.04	89.26	89.44	3.09	NS
AST (Iu/l)	58.73	58.39	59.45	57.52	58.25	1.41	NS
ALT (Iu/l)	64.26	65.81	65.81	66.68	65.10	1.58	NS
TAC (umol/l)	425.9	427.4	426.9	421.1	421.0	3.99	NS
MDA (umol/l)	10.6	10.7	11.4	11.1	10.9	0.08	NS
SOD (u/ml)	313.9	312.0	313.4	313.2	313.1	6.74	NS
Cort. (pg/ml)	3.16^{c}	3.45^{bc}	3.94^{ab}	4.36^{a}	4.34^{a}	0.32	**

Different superscripts in the same column indicate significant difference between means at P≤0.0٥.

SEM = Standard error of the means; NS=Not significant; **= Significant at P≤0.01

TP=Total protein; Alb=Albumin; Glb=Globulin; TL=Total lipids; TG=Triglycerides; TC=Cholesterol; HDL=high density lipoprotein; LDL=low density lipoprotein; AST=Aspartate aminotransferase; ALT=Alanine transaminase; TAC= Total antioxidant capacity; MDA= malondialdehyde; SOD= Superoxide dismutase; Cort.= Corticosterone

REFERENCES

Abou-Kassem, D. E. 2017. Effect of feed restriction system on performance, carcass traits, meat quality and blood parameters of growing rabbits. Egyptian J. Rabbit Sci., 27 (2): 359-375.

Alabiso, M.; DI Grigoli, A.; Mazza, F.; Maniaci, G.; Vitale, F. and Onanno, A. 2017. A 3-week feed restriction after weaning as an alternative to a medicated diet: Effects on growth, health, carcass and meat traits of rabbits of two genotypes. Animal 11: 1608-1616.

Allain, C. A.; Pon, L. S.; Chang, C. S. G.; Richmond, W. and Fu, P. C. 1974. Enzymatic determination of total serum cholesterol. Clinical Chemistry, 20, 470-475.

Bergaoui, R.; Kammoun, M. and Ouerdiane, K. 2008. Effects of feed restriction on the performance and carcass of growing rabbits. *9th World Rabbit Congress. Verona – Italy,*547-550.

Birolo, M.; Trocino, A.; Zuffellato, A. and Xiccato, G. 2016. Effect of feed restriction programs and slaughter age on digestive efficiency, growth performance and body composition of growing rabbits. *Anim. Feed Sci. Technol.,* 222., 194-203.

Birolo, M.; Trocino, A.; Tazzoli, M. and Xiccato, G. 2017. Effect of feed restriction and feeding plans on performance, slaughter traits and body composition of growing rabbits. World Rabbit Sci., 25: 113-122. doi:10.4995/wrs.2017.6748

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, Pueblo, Mexico, 759-764.

Cavani, C.; Petracci, M.; Trocino, A. and Xiccato, G.2009. Advances in research on poultry and rabbit meat quality. Ital. J. Anim. Sci., 8: 741-750.

Chabrol, E. and Charonnat, R. 1973. Determination of plasma total lipids. Press medical, 45: 1713-1720.

Di Meo, C.; Bovera, F.; Marono, S.; Vella, N. and Nizza, A. 2007. Effect of feed restriction on performance and feed digestibility in rabbits. Ital. J. Anim. Sci., 6 (Suppl. 1), 765-767.

Doumas, B. T.; Watson, W. A. and Biggs, H. G. 1971. Albumin standards and the measurement of serum albumin with bromocresol green. Clin. Chim. Acta, 31: 87-96. https://doi.org/10.1016/0009-8981(71) 90365-2

Duncan, D.B. (1955). Multiple ranges and multiple f-test, Biometries 11: 1-42.

Ebeid, T.; Tůmová, E. and Volek, Z. 2012. Effects of a one-week intensive feed restriction in the growing rabbit: part 1 - performance and blood biochemical parameters. Proc. 10th World Rabbit Congress-Sharm El-Sheikh -Egypt, 607- 61.

El-Speiy, M. E.; Kamel, K. I.; Tag El-Din, A. E.; Abd El-Hamid, A. E. and EL-Kamhawey, A. M. E. 2015. Effect of feed restriction on productive performance, carcass yield, blood pictures and relative organ weights of growing rabbits. *Egypt. Poult. Sci.,* 35 (2): 439-454.

Fadel, Magda M.; El -Iraqi, K. G.; Ghandour, Rehab A. and Foad, Manal A. 2019. Feed restriction regimens effects on growth and physiological performance of fattening rabbits. J. Egypt. Vet. Med. Assoc 79 (3): 791 – 802.

Foubert, C.; Duperray, J.; Boisot, P. and Guyonvarch, A. 2008. Effect of feed restriction with or without free access to drinking water on performance of growing rabbits in healthy or epizootic rabbit enteropathy conditions. In Proc., 9th *World Rabbit Cong.* Verona, Italy, 667-672.

Friedewald, W. T.; Levy, R. I. and Fredrickson, D. S. 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem, 18:499-502.

Gallois, M.; LE Huërou-Luron, I.; Fortun-Lamothe, L.; Lallès, J. and Gidenne, T. 2008. Adaptability of the digestive function according to age at weaning in the rabbit: I. Effect on feed intake and digestive functionality. Animal 2: 525-535.

Gidenne, T. and Feugier, A. 2009. Feed restriction strategy in the growing rabbit. 1. Impact on digestion, rate of passage and microbial activity. Animal, 3: 501-508.

Gidenne, T.; Combes, S. and Fortun-Lamothe, L. 2012. Feed intake limitation strategies for the growing rabbit: effect on feeding behavior, welfare, performance, digestive physiology and health: a review. Animal, 6: 1407-1419. https://doi.org/10.1017/S1751731112000389

Gidenne, T.; Combes, S.; Feugier, A.; Jehl, N.; Arveux, P.; Boisot, P.; Briens, C.; Corrent, E.; Fortune, H.; Montessuy, S. and Verdelhan, S. 2009. Feed restriction strategy in the growing rabbit: 2. Impact on digestive health, growth and carcass characteristics. Animal, 3: 509-515.https://doi.org/10.1017/S1751731108003790

Gidenne, T.; Feugier, A.; Jehl, N.; Arveux, P.; Boisot, P.; Briens, C.; Corrent, E.; Fortune, H.; Montessuy, S. and Verdelhan, S.2003. Un rationnement alimentaire quantitatif postsevrage permet de réduire la fréquence des diarrhées, sans degradation importante des performances de croissance: résultats d'une étude multi-site. *In: Proc. 10èmes Journ. Rech. Cunicole, Paris, France, 29–32.*

Gidenne, **T.; Fortun-Lamothe, L. and Combes, S. 2011.** Feed restriction strategies: implications on physiology, growth and health of the growing rabbit. *In Proc. Giornate di Coniglicoltura ASIC 2011. Forlì, Italy, pp.* 1-19.

Gidenne, T.; Garreau, H.; Drouilhet, L.; Aubert, C. and Maertens, L. 2017. Improving feed efficiency in rabbit production, a review on nutritional, technico-economical, genetic and environmental aspects. *Anim. Feed Sci. Technol.*, 225:109-122.

Gidenne, T.; Jehl, N. and Perez, J. M. 2005. Effect of cereal sources and processing in diets for the growing rabbit. II. Effects on performances and mortality by enteropathy. Anim. Res., 54: 65-72.

Henry, R. J. 1964. Clinical Chemistry: Principles and Techniques. Harper and Row Publishers, NewYork.

Jezová, D.; Giullaume, V.; Juránková, E.; Carayon, P. and Oliver, C. 1994. Studies of the physiological role of ANF in ACTH regulation. Endocr. Regul., 28: 163–169.

Knudsen, C.; Combes, S.; Briens, C.; Coutelet, G.; Duperray, J.; Rebours, G.; Salaun, J. M.; Travel, A.;

Weissman, D. and Gidenne, T. 2014. Increasing the digestible energy intake under a restriction strategy improves the feed conversion ratio of the growing rabbit without negatively impacting the health status. Livest. Sci., 169: 96 -105.

Koracevic, D.; Koracevic, G. and Djordjevic, V. 2001. Method for the measurement of antioxidant activity in human fluids. J. clini. pathol., 54, 356-361. http://dx.doi.org/10.1136/jcp.54.5.356

Maertens, **L. 2009.** Possibilities to reduce the feed conversion in rabbit production. *In Proc. Giornate di Coniglicoltura ASIC. Forlì, Italy, pp.* 1-10.

Maertens, L. 2010. Feeding systems for intensive production. In: C. de Blas and J. Wiseman (Eds.) Nutrition of the Rabbit. 2nd Edition. CAB International, Wallingford, Oxon, UK, 253-266. https://doi.org/10.1079/9781845936693.0253

Maertens, L. and Gidenne T. 2016. Feed efficiency in rabbit production: nutritional, technico-economical and environmental aspects. In: Proc. 11th World Rabbit Cong. Abstracts, Quingdao, China, 337-351.

Martignon, M. H.; Combes, S. and Gidenne, T. 2010. Digestive physiology and hindgut bacterial community of the young rabbit (*Oryctolagus cuniculus*): Effects of age and short-term intake limitation. Comp. Bioch. Physiol., Part A 156:156-162.

Mihara, M. and Uchiyama, M. 1978. Determination of malonaldehyde precursor in tissues by thiobarbituric acid test. Anal. Biochem., 86(1):271-278. https://doi.org/10.1016/0003-2697 (78)90342-1

Mousa, B. T. M.; El-Sheikh, R. A. and Moustafa, Esraa H. 2017. New strategies for controlling heat stress in New Zealand White (NZW) Rabbits in Egypt. Life Sci. J.; 14(11):64-70.

Nafeaa, Abeer; Abd Elfattah, A. S. and Fat Hallah, S. 2011. Effect of feed restriction during pregnancy on performance and productivity of new zealand white rabbit does. Veterinary Medicine International, ID 839737, 5 pages.

NRC. 1977. *Nutrient Requirement of Rabbits* (2nd ed.). National Academy of Sciences, National Research Council, Washington, DC., USA.

Oliveira, M. C.; Silva, R. P.; Araujo, L. S.; Silva, V. R.; Bento, E. A. and Silva, D. M. 2012. Effect of feed restriction on performance of growing rabbits. Braz. J. Anim. Sci. 41: 1463-1467.

Reitman, S. and Frankel, S. 1957. A colorimetric method for the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases. Amer. J. Clin. Pathol., 28, 56-63.

Rockville, M. D. 1991. Statgraphics Program, Version 5.0 Reference Manual.

Romero, C.; Cuesta, S.; Astillero, J. R.; Nicodemus, N. and De Blas, C. (2010). Effect of early feed restriction on performance and health status in growing rabbits slaughtered at 2 kg live weight. World Rabbit Sci, 18: 211 – 218. doi:10.4995/wrs.2010.778

Sawle, A.; Higgins, M. K.; Olivant, M. P. and Higgins, J. A. 2002. A rapid single-step centrifugation method for determination of HDL, LDL and

VLDL cholesterol and TG and identification of predominant LDL subclass. J. Lipid Res., 43, 335-343.

Tietz, N. W. 1995. Clinical Guide to Laboratory Tests (2nd ed.). WB Saunders Company. Philadelphia, USA.

Tumova, E.; Skrivanova, V. and Skeivan, M. 2003. Effect of restricted feeding time and quantitative restriction in growing rabbits. Arch. Geflugelkde, 67: 182-190.

Tumova, E.; Skrivanova, V.; Zita, L.; Skrivan, M. and Fuclkova, A. 2004. The effect of restriction on digestibility of nutrients, organ growth and blood picture in broiler rabbits. *In Proc.:* 8th World Rabbit Congress, Puebla, Mexico, 1008-1014.

Tumova, E.; Volek, Z.; Chodová, D.; Härtlová, H.; Makovický, P.; Svobodová, J.; Ebeid, T. A. and Uhlířová, L. 2016. The effect of 1-week feed restriction on performance, digestibility of nutrients and digestive system development in the growing rabbit. Animal, 10: 1-9.

Tumova, E.; Zita, L.; Skřivanova, V.; Fučikova, A.; Skřivan, M. and Burešova, M. 2007. Digestibility of nutrients, organ development and blood picture in restricted and ad libitum fed broiler rabbits. Archiv. für. Gefl., 71: 6-12.

Tumova, E.; Zita, L. and Stolc, L. 2006. Carcass quality in restricted and *ad libitum* fed rabbits. Czech J. Anim. Sci., 51, 214–219.

Uhlířová, L.; Volek, Z.; Marounek, M. and Tůmová, E. 2015. Effect of feed restriction and different crude protein sources on the Performance, health status and carcass traits of growing rabbits. World Rabbit Sci., 23: 263-272. doi:10.4995/wrs.2015.3229

Van Harten, S. and Cardoso, L. A. 2010. Feed restriction and genetic selection on the expression and activity of metabolism regulatory enzymes in rabbits. Animal, 4:1873-1883.

Yassein, S. A.; Sekena, H. A. A.; El-Mallah, G.M. and Maghraby, N. A. 2011. Response of growing rabbits to feed restriction and some additives on performance, carcass and hepatic gene expression under egyptian summer conditions. J. Agric. Sci., (3)2: 45-55. doi:10.5539/jas. v3n2p45

Yi-Sun; Larry, W. and Ying, Li. 1988. A simple method for clinical assay of superoxide dismutase. Clin Chem. 3413: 497-500.

الملخص العربى

تأثير تحديد الغذاءعلى الاداء الانتاجى والكفاءة الإقتصادية للأرانب النيوزلاندى البيضاء المفطومه

سارة خليل شريف
قسم انتاج الدواجن – كلية الزراعة – جامعة المنصورة – مصر

اجريت هذه التجربة لدراسة تأثير تحديد الغذاء على الأداء الإنتاجى للأرانب النيوزلاندى البيضاء المفطومه. تم تقسيم عدد خمسة وسبعون من الأرانب غير المجنسة (عمر خمسة اسابيع) على خمس معاملات تجريبية بكل منها خمس مكررات. برنامج تحديد الغذاء استخدم فى اول اسبوعين بعد الفطام (٥-٧ اسابيع من العمر) كالتالى: حيث المجموعة الكنترول غذيت على العليقة التجريبية حتى الشبع بدون تحديد، لكن باقى المجموعات التجريبية من الثانية للخامسة تم تحديد الغذاء لها بالمستويات ١٠، ٢٠، ٣٠، ٤٠% على التوالى من المأكول بالمجموعة الكنترول. كل الأرانب التجريبية غذيت حتى الشبع على العليقة النامية فى الفترة من عمر ٨-١٢ اسبوع. تم تقييم الأداء الانتاجى للأرانب ومواصفات الذبيحة ومعدل النفوق والكفاءة الاقتصادية وتقدير بعض مكونات سيرم الدم.
اوضحت النتائج الحالية ان تحديد الغذاء غطى الوزن الحى عند التسويق وحدث تحسن فى معامل الاستفادة من الغذاء. وبرنامج تحديد الغذاء لم يؤثر على مواصفات الذبيحة. ومقاييس سيرم الدم لم تتأثر معنويا بتحديد الغذاء. ويمكن استنتاج ان تحديد الغذاء بمستويات ٣٠ أو ٤٠ % خلال اول اسبوعين بعد الفطام ادى لتأثير ايجابى على الأداء الإنتاجى للأرانب، وحسن معامل التحويل الغذائى والكفاءة الاقتصادية وخفض معدل النفوق.