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IMPACT OF BREED AND FEED RESTRICTION ON CARCASS TRAITS IN THE GROWING RABBITS

S. Ahmed[1], S.M.A. Sallam[2], Omnia Essa[1], T. Rabie[1]

1- Department of Animal Production and Fish resources, Faculty of Agriculture, Suez Canal University, 41522, Ismailia, Egypt, 2- Department of Animal and Fish Production, Faculty of Agriculture, (El-Shatby) Alexandria University, Alexandria, Egypt

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SUMMARY

The aim of current study was to evaluate the effect of rabbit' breeds (Red Baladi (RB), and New Zealand White (NZW) breeds), and feed restriction for two weeks (started at 11 and 12 weeks age till they reached 15 weeks of age) on growth performance traits (live body weight and carcass characteristics of growing rabbits). Rabbits were fed ad libitum till they reached 11 weeks of age. Three experimental groups were performed; 1st group was the control 0%, 2nd and 3rd groups were fed 60% and 80% from ad libitum feeding, respectively. This study resulted in, not only the body weight was affected either by breeds or feed-restriction, but also the feed intake and feed conversion ratio (FCR) were significantly affected. In addition, viability rate (%) during feed restriction to slaughter was similar in all studied groups. Interestingly, although, feed restriction hadn't effect on scaling a percentage or total edible parts at slaughter, the breeds showed the significant effect on these traits. Furthermore, there were significant effects of breed, feed restriction, and their interactions on both abdominal fat and viscera. Additionally, there were no significant effects of either breeds or feed restriction on kidney weight, but the liver weight affected significantly by interactions between breed and feed restricted. In conclusion, the feed restriction was recommended for two weeks period starting from 11th week of rabbit's age to enhance the growth performance and the carcass characteristics of rabbits.

Keywords: restriction feeding, growth performance, carcass characteristics

INTRODUCTION

Due to its high meat quality, low fat, in addition to the quantity of meat provided by rabbits, it is a very valuable source of protein for human food (Gidenne *et al*., 2009[a]). However, rabbit's breeders faced a big problem due to dam isolation, weaning shock and transition to a new solid feed, which may increase the sensitivity of rabbits to diseases (Gallois *et al*., 2008). High mortality in rabbit weaning is due to contagious digestive disorders (Marlier *et al*., 2003), which are widespread in rising rabbits and cause many morbidity and mortality in commercial rabbit farms. Additionally, digestive conditions are minimized by the feed restriction (Gidenne *et al*., 2009b), which attributable to improve of both nutrients digestibility and feed management (Di Meo *et al*., 2007; Abdel-Wareth *et al*., 2015). After that, time of feed restriction, compensated growth depends on the time, rate and style of feed restriction (Di Meo *et al*., 2007; Gidenne *et al*., 2009b; Romero *et al*., 2010; Abdel-Wareth *et al*., 2015). Feed restriction helps to prevent digestive system diseases that affect young rabbits from weaning to 10 weeks of age (Gidenne *et al*. 2009c), reduce feed intake, which has a positive effect on feed efficiency (Di Meo *et al*., 2007; Gidenne *et al*., 2009c, 2012).

In addition, it reduces carcass fat and improves FCR (Gidenne and Feugier (2009). Accordingly, Di Meo *et al*. (2007); Gidenne *et al*. (2012) found that the post-weaning mortality rate was reduced and improved FCR, due to restriction feed regime. Also, Tumova *et al*. (2003) and Dalle Zotte *et al*. (2005) observed that restriction feed in the percentage of 60% was more effective than 80% to promotes compensatory development by real iminishing and enhances FCR and decreases body fat. Furthermore, feed restriction strategist can be divided into two classes;1- a medium restriction during growth (Gidenne *et al*. (2003); 2- feed restriction on it at the beginning of growing period followed by ad-labium till slaughtering (Radnai *et al*., 2005). The pervious feed techniques also enabled to improve feed efficiency, reduce abdominal fat weight in the carcass (Laurence *et al*., 2003). However, in several other studies, the FCR for rabbits treated with restricted feed was found to be similar to that groups fed ad libitum. Furthermore, low sacrificial weight resulted in feed intake reduction by 4.5%. However, during the real imentation period, the rabbits are compensated growth is as the results of feed intake increasing (Tumova *et al*. 2016; Gidenne *et al*., 2009[a]). Finally there are no impacts on the sacrificial characteristics result to feed restriction strategies (Larzul *et al*. 2004; Gidenne *et al*., 2009a).The aim of the current experiment was to study the effect of two levels of feed restriction (60% and 80%) compared to *ad- libitum* feeding regime on growth and carcass performance of growing rabbits.

MATERIALS AND METHODS:-

The present experiment was carried out at the Rabbits Research Farm, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during the period from September 2017 to February 2018.

Experimental design and rabbitry management:

Two breed were selected (73 animals of each of Red Baladi and New Zealand White breeds). Rabbits weaned at 28 day were divided into three groups; each group has 16 of animals and kept individually in galvanized wire batteries with automatic nipple drinkers and provided with separated feeders. Lighting system was sixteen hr light/eight hr dark in the rabbitry during experimental period. The rabbits were apparently healthy and free of any external parasites or skin diseases. Pre-experiment was conducted to carry out the amount of *ad-libitum* feed to calculate the feed restriction levels upon the total daily feed intake. The feed restriction started at 11^{th} week for two weeks (*ad-libitum* a control, 60% and 80% from ad-libitum), while at the beginning 13^{th} week of age the treated groups were fed *ad-libitum* feeding continuously till the slaughter at 15 weeks of age. The calculated chemical composition of the diet were 18% crude protein, 2.69% fat, 12.39% crude fiber and 2738 kcal digestible energy/kg diet according to NRC (1984).

Performance and carcass traits:

Growth traits:

At the early morning on the same day of the each week rabbits were individually weighed weekly. Then the body weight gain was calculated, feed intake (g), feed conversion ratio (kg feed/kg gain) and mortality rate was recoded.

Slaughter traits:

At the end of the 15^{th} week of age, the rabbits were individually weighed. Six rabbits per treatment were selected, kept off feed for 12 h and slaughtered to evaluate the carcass traits after removing both abdominal fat and viscera. The legs, skin, fur, heart, liver and kidneys were individually weighed. The carcass weight and scaling of edible parts was expressed as a percentage of live body weight.

European Efficiency factors (EEf):

European Efficiency factors (EEf) was calculated as the following:

EEF= (weight gain (g)/age day) × (viability rate %/ feed conversion ratio (kg feed/kg gain):10, according to Nilipour, (1998).

Statistical analysis:

Data were statistically analyzed using General Linear Models Procedure of the SPSS 20 program (2015).The following model was used to study the effect of main factors and interaction between feed restriction (FR) and Breed (B) on recorded traits as follows:-

$Y_{ijk} = \mu + F_i + B_j + (FR)_{ij} + e_{ijk}$

Where :Yijk=An observation μ = overall mean ; F_i = effect of FR level; I = (1,2 and 3); B_j = effect of breed; $_j$=(1 and 2); FR $_{ij}$ = effect of interaction between FR and B (ij (1,2….6); and $_{ejik}$= Experimental error. The Differences means among treatments were subjected to Duncan´ s Multiple Range- test (Duncan, 1955).

RESULTS

Growth Performance:

Effect of feed restriction in body weight:

The effect of the breed and feed restriction levels on body weights during feed restriction (11and 12^{th} weeks of age) and the free feeding period from 13 to 15^{th} weeks of age and their interaction presented in Table (1). The results revealed that although feed restriction levels had significantly ($P\leq 0.05$) negative effect on body weight during feed restriction. It had significantly ($P\leq 0.05$) positive effect after feed restriction. However, there was significant interaction effect between breed and the level of feed restriction levels on body weight ($P\leq 0.05$) at 13 and 14^{th} weeks. At the beginning of feed restriction, a drop in rabbits growth was observed accompanied by reducing of feed intake in restricted rabbits during the feed restriction period, when animals are again fed *ad libitum*, compensatory growth is observed during the real imentation period, and its related with level of feed restriction. These results are symmetrical with many reports of Tumová *et al*., 2003; Yakubu *et al*., 2007; Gidenne and Feugier, 2009; Gidenne *et al*., 2009b; Gidenne *et al*., 2012;Oliveira *et al*., 2012; Alabiso *et al*., 2016; Tumova, Volek *et al*., 2016 and Birolo *et al*., 2017). Although, both breed had a significant effects and restriction feed treatments on body weight, which in agreement with Tumová *et al*., 2003; Yakubu *et al*., 2007 and Gidenne *et al*., 2012), where they found no significant effects and explained it by the differences of the levels and duration of feed restriction treatments (Gidenne *et al*., 2012).

Effect of feed restriction on feed intake, feed conversion and mortality rate (%):

The difference of the feed intake was significantly lower in the 60% restriction feeding (FR1) group than the control group (FR0) ($P<0.05$). Total feed intake of rabbits was not significantly ($P>0.05$) differed between two breeds, which might be due to equality total feed intake among treatments. Moreover, FCR (kg feed/kg gain) and EEf were significantly lower in the control group (FR0) than in the (FR1) group ($P<0.05$), with no significant effect of the breed ($P< 0.05$) presented in Table (3). In current study, feed intake was similar for both the determination rabbits and the ad libitum groups agrees with those of Tumova *et al*. (2003); Romero *et al*. 2010), where different feed intake results might be related to feeding behaviors (Gidenne *et al*., 2012). In addition Gidenne *et al*. (2009a) found that the compensatory growth was not associated with evolved feed conversion in contradictory with current results where FCR was increasing in restricted feed groups compared to *ad-libitum* group. Concerning the mortality rate (%), during feed restriction to slaughter was similar with no records of mortality in the treatment groups. Ebeid *et al*. (2012) reported that the feed restriction had no effect on mortality rate of the rabbits. On contrast, Gidenne *et al*., (2012) stated that restriction period (for 2 or 3 weeks) decreased mortality rate and morbidity from digestive problems. Morover, the duration of restriction feed had no influence on mortality percentage as reported by Gidenne *et al.*(2003); Yakubu *et al.*(2007).

Table 1. Effect of breed, feed restriction and their interaction on body weight (g) at different age

Weeks	Breed		FR			Inter. Effects: B*FR					
	BR	NZW	FR0	FR1	FR2	BR*FR0	BR*FR1	BR*FR2	NZW*FR0	NZW*FR1	NZW*FR2
W11	1274.7^{b} ±4.0	1380.4^{a} ±4.0	1401.2^{a} ±4.9	1275.5^{ab} ±4.8	1306.^{0b} ±4.9	1349.6^{a} ±6.9	1215.3^{a} ±6.9	1258.9^{a} ±6.9	1452.6^{a} ±6.9	1335.6^{a} ±6.8	1353.0^{a} ±7.0
W12	1336.3^{b} ±5.3	1454.1^{a} ±5.3	1602.9^{a} ±6.4	1267.4^{ab} ±6.4	1315.3^{b} ±6.5	1551.4^{a} ±9.1	1196.0^{a} ±9.1	1261.7^{a} ±9.1	1654.8^{a} ±9.1	1338.1^{a} ±8.9	1368.8^{a} ±9.3
W13	1631.3^{b} ±4.9	1789.8^{a} ±4.9	1805.7^{a} ±6.0	1652.3^{ab} ±6.0	1673.6^{b} ±6.1	1753.7^{a} ±8.5	1556.7^{ab} ±8.5	1583.4^{b} ±8.5	1857.7^{a} ±8.5	1747.9^{ab} ±8.4	1763.9^{b} ±8.7
W14	1960.1^{b} ±3.7	2122.3^{a} ±3.7	2005.7^{ab} ±4.6	2056.9^{b} ±4.5	2061.0^{a} ±4.63	1954.8^{ab} ±6.5	1960.8^{b} ±6.5	1964.6^{a} ±6.5	2056.6^{ab} ±6.5	2153.0^{b} ±6.3	2157.4^{a} ±6.6
W15	2156.7^{b} ±6.7	2411.4^{a} ±6.7	2234.8^{ab} ±8.2	2306.8^{b} ±8.1	2310.6^{a} ±8.3	2125.6^{a} ±11.6	2161.2^{a} ±11.6	2183.3^{a} ±11.6	2344.1^{a} ±11.6	2452.4^{a} ±11.3	2437.8^{a} ±11.8

RB: Red Baladi Breed; NZW: New Zealand White Breed; FR0: control diet; FR1:60% of the diet; FR2:80% of the Diet; B *FR: Interaction between breed and feed;±: standard error of the mean;a-b Means within the same row with the different superscript letter are significantly different (p >.05).

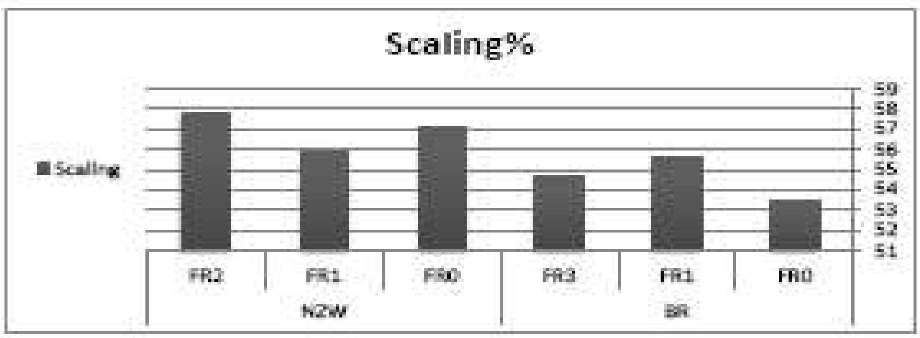

Figure 1. Effect of breed and feed restriction in scaling (%).

Effect of feed restriction in carcass traits:

The carcass traits are shown in Table (2, 3). Significant effect of breed, feed restriction, and their interaction for 15 weeks of age were noticed on the carcass weight. The carcass, heart, fat abdominal, viscera, skin and fur weights were affected significantly (P<0.05) by breed. However, the levels of feed restriction were significantly (P<0.05) affected the heart, the fat abdominal, the skin and fur weights (g). Moreover, interaction effects between breed and levels of restriction feeding were significantly (P<0.05) impacted on the heart, the liver, the fat abdominal and viscera weights. The carcass characteristics are important factors to evaluate the feeding programs (Ledin 1984), as with growth performance, the feed restriction can change body composition, and carcass weights. Differences in rabbit carcass traits have been observed under high level or long limited periods (Gidenne *et al.* 2009a; Metzger *et al.* 2009) and differences in the development of carcass parts with increasing age (Pascual *et al.*, 2008).

The current results indicated that group with the highest level of feed restriction had the lowest body weight during the restriction of feed period, but at slaughter the differences between levels of feeding were not significant, which agreed with Tumov *et al.* (2006); Bovera *et al.* (2013); Birolo *et al.* (2017). On contrast, Olajide and Ayoola, (2012); Chodova *et al.* (2016) found lower carcass weights in the feed restriction group than in an *ad-libitum* group, which are not consistent with current study. On current study feed restriction had not effect on scaling percentage at slaughter, as was also observed by Tumov_a *et al.* (2003, 2006); Oliveira *et al.* (2012); Alabiso *et al.* (2016). However, the level of feed restriction resulted in a lower percentage in scaling in restriction feeding rabbits groups (Chodov *et al.*, 2016), which in harmony with the results of the current study. The non-significant effect of feed restriction in scaling % and total edible parts at slaughter was in agreement with many previous studies (Combes *et al.*,2003; Tůmova *et al.*,2003 and Boisot *et al.*,2004). On the other hand, Matics *et al.* (2008); Metzger *et al.* (2009) had observed a few effect of feed restriction. A significantly higher proportion of legs in *ad-libitum* fed group compared with restriction fed groups were stated by Combes *et al.* (2003), which are in contrast with the current results. Moreover, the importance of feed restriction is reducing of total amount of feed intake, in such way improve the carcass composition and reduced the abdominal fat, which in the same direction of the results reported by Metzger *et al*., 2009; Chodov *et al*. 2016).

Table 2. Effect of feed restriction, breed on carcass traits at slaughter age (15) weeks (g)

Traits	Breed		FR		
	BR	**NZW**	**FR0**	**FR1**	**FR2**
Carcass(g)	1122.5^{b}±10. 9	1324.8^{a}±10.9	1210.8^{a}±13.3	1226.2^{a}±13.2	1233.9^{a}±13. 5
Heart(g)	7.6^{b}±0.3	8.9^{a}±0.3	9.5^{a}±0.4	6.7^{ab}±0.4	8.6^{b}±0.4
Liver(g)	80.5^{a}±2.1	75.8^{a}±2.1	80.4^{a}±2. 6	79.4^{a}±2.5	74.7^{a}±2.6
Kidneys(g)	14.2^{a}±0.4	14.9^{a}±0.4	15.4^{a}±0.5	14.3^{a}±0.5	13.9^{a}±0.5
Head(g)	91.8^{a}±0.8	97.4^{a}±0.8	96.1^{a}±0.9	93.2^{a}±0.9	94.8^{a}±0.9
Fat Abdominal(g)	7.9^{b} ±0.2	8.5^{a} ±0.2	12.7^{a}±0.2	3.7^{c} ±0.2	8.2^{b}±0.2
Viscera(g)	357.9^{a}±5.7	324.7^{b}±5.7	350.4^{a}±7	338.4^{a} ±6.9	335.2^{a}±7.1
The legs(g)	71.8^{a}±0.9	74.8^{a}±0.9	74.6^{a}±1	72.1^{a}±1	73.1^{a}±1.1
Skin and fur(g)	271.3^{b}±4. 5	279.5^{a}±4.5	284.4^{a}±5.5	257.9^{ab}±5. 4	283.8^{b}±5.5
Scaling (%)	54.6^{a}	56.9^{a}	55.3^{a}	56.2^{a}	55.7^{a}
Total edible parts	1316.7^{a} ±11	1521. 9^{a}±11.1	1412.1^{a}±13.5	1419.9^{a}±13.4	1425.9^{a}±13. 7

RB: Red Baladi Breed; NZW: New Zealand Breed;FR0: control diet; FR1: 60% of the diet; FR2: 80% of the diet;±: standard error of the mean;

$^{a-c}$Means within the same row with the different superscript letter are significantly different (p>.05).

Table 3. interaction effects between breed and feed restriction on feed intake (g), feed conversion ratio (kg feed/kg gain), economic efficiency factors and carcass traits at slaughter age (15) weeks (g)

Inter. Effects* FR						
Traits	**BR*FR0**	**BR*FR1**	**BR*FR2**	**NZW*FR0**	**NZW*FR1**	**NZW*FR2**
Carcass(g)	1083.3^{a}±18.9	1147.5^{a}±18.9	1136.6^{a}±18.9	1338.3^{a}±18.9	1320.4^{a}±19.8	1315.8^{a}±18.5
Heart(g)	8.6^{a}±0.6	6.8a^{b}±0.6	7.5^{b}±0.6	10.3 ^{a}±0.6	10.3^{b}±0.6	5.9^{ab}±0.6
Liver(g)	88.1^{a}±3.6	76.1^{ab}±3.6	77.4^{b}±3.6	72.8^{ab}±3.6	73.3^{b}±3.7	81.40^{a}±3.5
Kidneys(g)	15.1^{a}± 0.75	13^{a}± 0.8	14.6^{a}±0.8	15.8 ^{a}±0.8	14.9^{a}±0.8	14.1^{a}±0.7
Head(g)	94.4^{a}±1.3	90.9^{a}±1.3	90.3^{a}±1.3	97.8^{a}±1.3	98.7^{a}±1.3	95.9^{a}±1.3
Fat abdominal(g)	12.3^{a}±0.3	7.1^{b}±0.3	4.5^{c}±0.3	13.1^{a}±0.3	9.3^{b}±0.3	3^{c}±0.3
Viscera(g)	387.6^{a}±9.9	344.6^{b}±9.9	341.6^{ab} ±9.9	313.1^{ab}±9.9	325.8^{b}±10.1	335.2^{a} ±9.7
legs(g)	72.6^{a}±1.5	70.3^{a}±0.8	72.4^{a}±1.5	76.5^{a}±1.5	76.0^{a}±1.5	71.9^{a}±1. 5
Skin ,fur(g)	288.4^{a}±7.7	281.3^{a}±7.7	244.1^{a}±7.7	280.4^{a}±7.7	286.4^{a}±7.9	271.6^{a}±7. 6
Scaling (%)	53.5^{a}	55.6^{a}	54.7^{a}	57.1^{a}	55.9^{a}	57.8^{a}
T. edible parts	1289.4^{a}±19.1	1334.3^{a}±19.1	1326.5^{a}±19.1	1534.9^{a}±19.1	1517.5^{a}±19.5	1513.2^{a}±18.7
T.F.I	7175^{a}	6895^{b}	6615^{ab}	7175^{a}	6895^{b}	6615^{ab}
FCR	3.37^{a}	3.07^{b}	2.82^{ab}	3.04^{a}	2.82^{b}	2.88^{ab}
E.E.f	5.9^{ab}	6.7^{b}	7.3^{a}	7.2^{ab}	8.3^{a}	8.1^{b}

RB: Red Baladi Breed; NZW: New Zealand Breed;FR0: control diet; FR1:60% of the diet. FR2:80% of the diet *FR: Interaction between breed and feed; T.F.I: total feed intake (g) from (4) weeks to slaughter; FCR: Feed conversion ratio (kg feed/kg gain) at slaughter; (EEf):Economic Efficiency factor

On the other hand, other studies showed that feed restriction has relatively affected on relative organ weights (Matics *et al*., 2008; Metzger *et al*., 2009), although the weights of internal organs (liver and kidneys) were not affected at the current study using feeding restriction, which inconsistent with Tumová *et al*., 2007, while the heart weight was affected by restriction feeding as also found by Tumová *et al*.(2006). These results can attributed to priority is given to the internal organ maintenance in periods of feed scarcity, the lower protein content in the cells, accompanied by depression in cell size due to feed restriction, which resulted in the heart weight will be reduced than normal.

CONCLUSION

Feed restriction for two weeks starting from 11th week of age was recommended because it had a positive and economical effects on rabbits performance and carcass traits.

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تأثير السلالة وتحديد مستوى العلف على صفات الذبيحة فى الأرانب النامية

سليمان أحمد[١]، [٢]صبحى محمد سلام[٢]، أمنية عيسي[١] ، طارق ربيع[١]

١ ـ قسم الإنتاج الحيوانى، كلية الزراعة، جامعة قناة السويس، الإسماعيلية، مصر، ٢ ـ قسم الإنتاج الحيوانى والسمكى، كلية الزراعة، جامعة الإسكندرية، الإسكندرية، مصر

تهدف هذه الدراسة الحالية إلى تقييم تأثير كلاً من سلالة الأرانب (أرانب البلدى الأحمر والنيوزلاندى الأبيض) وتحديد كميات العلف وذلك لمدة أسبوعين إبتداءاً من الأسبوع الحادى عشر والثانى عشر وحتى عمر التسويق فى الأسبوع الخامس عشر من العمر وذلك على الصفات الخاصة بمعدل نمو والصفات الخاصة الذبيحة للأرانب النامية وقد تم تغذية الأرانب قبل الأسبوع الحادى عشر والثانى عشر تغذية حرة. تم عمل ثلاث مجموعات تجريبية: المجموعة الأولى هي المجموعة الكنترول , المجموعة الثانية والثالثة تم تحديد كمية العلف في الأسبوع الحادي عشر والثاني عشر فقط بنسبة ٦٠٪ و ٨٠٪ من كمية العلف المغذى عليها المجموعة الكنترول علي الترتيب.

أوضحت نتائج الدراسة أن وزن الجسم الحى تأثر ليس فقط بالسلالة إنما أيضاً بتحديد كمية العلف كما تأثر بشكل معنوى كلاً من كمية الغذاء المستهلك وكفاءة التحويل الغذائى وأيضاً وجد أن معدل الحيوية أثناء فتره تحديد كمية العلف حتى الذبح كان متشابه فى جميع المجموعات. وعلى الرغم من أن تحديد العلف لم يؤثر على نسبة التصافى والأجزاء الصالحة للأكل إلا أنه قد وجد تأثر بشكل معنوى لإختلاف السلالة. بالإضافة إلى ذلك لم نجد أى تأثير معنوى لكلاً من السلالة وتحديد كميات العلف على وزن الكلى والكبد وأيضاً لم يتأثران بتداخل التأثير المشترك لكلاً من تحديد كمية العلف والسلالة معاً.

ونستنتج من هذه النتائج أن تحديد كمية العلف إبتدءاً من الأسبوع الحادى عشر ولمدة أسبوعين قد أدت إلي تحسين كلاً من الصفات الخاصة بالنمو وصفات الذبيحة في الأرانب.