Effects of Genotype by Weaning Age Interaction on Growth Traits in Rabbit

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ABSTRACT

Weaning age is an important event that affects the growth and health of weaned animals which has many impacts on mortality and growth traits. An experiment was conducted to study genotype (G) and weaning age (WA) interaction (G×WA) effects on growth traits of the animals belonged to two lines of rabbit (APRI and V line) reared under Egyptian conditions. Multiparous rabbit does were serviced to obtain 225 litters with 1800 young rabbits at weaning. The weaning ages ranged from 26 to 43 days where the young rabbits were weaned at different ages (≥28d (WA1); 28 < T ≥ 35d (WA2); 35 < T ≥ 40d (WA3) and 40<Td (WA4)). Body weight from 4 to 16 weeks of age (BWt) and corresponding average daily gain (ADGt1-t2) were measured. APRI rabbit line was significantly heavier body weight compared to V line at the different ages. At the end of the fattening period (FP), the difference was 104g per animal with higher ADG during the whole period. Regarding the weaning age effects, positive effects were observed where the heaviest BW was observed at FP ADG of rabbits weaned in late weaning was higher than in early weaning with significant differences. The observed results suggest the existence of relevant G×WA interaction for these traits where is recommended to wean the young rabbits between 29-35 days while for rabbits of V line is recommended the weaning age after 35 days. The study confirmed that early weaning is not preferable in rabbit under Egyptian conditions, and it is better to wean young rabbits have at least 30 days of age to achieve best body weight and growth rate.

KEYWORDS: Rabbit; Weaning age; G×WA interaction; Growth traits; Fattening period

INTRODUCTION

In recent years, interest in rabbit production has increased due to its economic and health importance for humans, as it is considered an ideal solution to the growing protein shortage in developing countries [1-3]. The weaning of kits in rabbit is a very critical event during the life of rabbit females because that event has important effects on the health state on the weaning kits and their does. Moreover, the weaning age effects can result in health (gut health) and performance during the fattening period, particularly during the first weeks after weaning. Also, weaning age has an effective strategy on the body condition of the does, such as energy deficit and body lipid depots by limiting the duration of lactation and reproduction rhythm [4,5]. The health and mortality of weaned rabbits are affected by weaning age [4,6]. The first question about weaning is that at what age can the litter technically be separated from the does. The results of the weaning age effects on the mortality and the yields of the kits during the fattening are contradictory. Lebas [7] commented that late weaning is normally recommended to reduce the mortality post-weaning. Also, Gidenne [8] found a higher mortality between 32 and 45 days in kittens weaned at 23 days than in those weaned at 32 days (17.2% vs. 9.2%).

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Moreover, body weight and gut microbiota are affected by weaning age [9,10]. De Blas et al. [11] found that in 35-day weight of the kits weaned at 25 days was lower than that of those animals that were weaned at 35 days (750 vs. 870g, respectively), although all finished the bait with the same weight (2.0kg) due to the compensatory growth that the first ones had. The objective of this work is to study the effects of genotype and weaning age interaction (GxWA) on growth traits of the animals belonged to two lines of rabbit on kits performance during the fattening period under Egyptian conditions.

MATERIALS AND METHODS

Ethics Statement

All experimental procedures were approved by the Committee of Ethics and Animal Welfare of Animal Production Research Institute, Sakha, Kafr El-Sheikh Governorate, Egypt.

Animals

The present study was conducted involving synthetic Egyptian line (APRI) and a Spanish maternal line (V line). Rabbits raised at the Experimental Rabbity of Animal Production Research Institute, Sakha, Kafr El-Sheikh Governorate, Egypt. The analysis included the growth data recorded for APRI and V lines during 2019.

The APRI is a maternal line. It was founded in 2008 at the Animal Production Research Institute, Egypt [12]. This line was founded as a synthetic line from the cross of Baladi Red bucks with V line does to get F1. After its foundation, it was selected for litter weaning weight. Where the V line was established from four specialized maternal lines in 1984 into a composite synthetic line which the method of evaluating the animals is by BLUP under a repeatability animal model [13].

The multiparous rabbit does were serviced 12-14 days post-kindling and a pregnancy test was carried out by abdominal palpation on day 14 after mating. Litters born were examined and recorded for total number born and number born alive. Litters were reared by their dams until weaning. One thousand and eight hundred young rabbits were chosen, to be weaned from a litter of hundred young rabbits at birth at 8 kits of 225 litters.

At weaning, the young rabbits were individually identified by a number tattooed on the ear. The first age for weaning of kids were equalized at birth at 8 kits of 225 litters. The difference in body weight at 4 weeks was around 80g in the present study period (from 4 to 6wk (ADG8-10)), 10-12wk (ADG16-18), 12-14wk (ADG18-20), 14-16wk (ADG16-18), overall fattening period (ADG18-20) was measured at 4 (BW4) to 16 (BW16) weeks of age. These days correspond to age at 4 weeks, 6th week, 8th week, and the week of slaughter (at 10 weeks of age) and advanced weeks of age, respectively. Individual average daily gain (ADGt-t2) during the study period (from 4 to 6wk (ADG8-10), 6-8 wk (ADG10-12), 8-10wk (ADG12-14), 10-12wk (ADG14-16), 12-14wk (ADG16-18), 14-16wk (ADG18-20), overall fattening period (ADG18-20) was calculated.

Statistical Analysis

The obtained data for the two lines were used in the analysis where univariate animal models were fitted to estimate the genetic parameters for all traits. A total of 2231 individuals were be obtained from 371 parities for the two lines were analysed using the following model:

\[ Y_{ijklmn} = YS_i + P_{ij} + \beta (NBA_k) + L_{i} + L_{j}P_{i} + e_{ijklmn} \]

Where;

- \( Y_{ijklmn} \) is a record of growth traits; \( YS_i \) is a fixed effect; year-season of the parity (one year season every three months: 3 levels); \( P_{ij} \) is a fixed effect, parity order of the doe (3 levels); \( NBA \) is a covariate including the number of born alive in the litter in which the animal was born, being \( \beta \) the regression coefficient, \( L_{i} \) is a fixed effect, line effect (2 levels); \( L_{j}P_{i} \) is a fixed effect, interaction (3 levels); \( L_{j}P_{i} \) is a fixed effect, lactation-length (4 levels); \( L_{j} \times L_{k}P_{i} \) is the effect of line-weaning age interaction; \( e_{ijklmn} \) is a random effect, residual of the model.

To test the significant of the used effects in the model, factorial ANOVA was applied using the GLM procedure of SAS 9.2 [14]. The different levels of each effect included in the models were compared by using Duncan’s multiple range test where significance levels were detected as first-class error at \( \alpha = 0.05 \).

RESULTS AND DISCUSSION

Table 1 shows descriptive statistics of the analysed body weight traits, including their number, mean, standard deviation, and minimum and maximum values which take into account the entire data. The actual means of post-weaning body weight are within the ranges of literature reported about the same lines under Egyptian [12,15,16].

Means of body weight traits at different weeks of ages for APRI and V lines in the current experiment were presented in Table 2. Differences in weaning weight are economically important where the observed results showed that APRI line is superior to V line in all body weight traits during the whole period of the experiment with significant differences.

The difference in body weight at 4 weeks was around 80g in favor of line APRI with a significant difference and thus observed differences could be explained because fattened rabbits of the APRI line came from litters with the lowest number of kits born alive and the lowest number of rabbits at weaning. Orengo et al. [17] reported that heavier body weights at weaning were obtained when litter size at birth was lower. Moreover, previous studies confirmed that body weight at weaning has been shown to be associated with milk production [18,19].
Regarding body weight after weaning, the body weight differences were in favor of the line APRI and the difference increased with V line after the 6 weeks of age. At the end of the fattening period (BW), the differences in favor of APRI line comparing with V line (1706.94 vs. 1601.41). Moreover, the differences at the end of study period reached to be more than 100g per animal favoring APRI line.

This could be partially attributed to that APRI rabbit could be still affected by its foundation where theoretically containing 50% of its constituents from Egyptian strain (Red Baldi) genes which are more adapted to the Egyptian climatic conditions. Also, selection program has been effective in achieving genetic improvement in litter weight traits for APRI rabbits.

Table 1: Basic statistics for body weight traits (g) at different ages (Number of observation (N), Mean, standard deviation (SD) and extreme values).

BW (4,6,8,10,12,14,16): Body weight at 4, 6, 8, 10, 12, 14, 16 weeks of age, respectively.

| Traits | N  | Mean          | SD  | Minimum | Maximum |
|--------|----|---------------|-----|---------|---------|
| BW<sub>4</sub> | 1799 | 472.0±2.65    | 112.78 | 226      | 991.5   |
| BW<sub>6</sub> | 1799 | 793.4±3.18    | 135.07 | 365      | 1531.1  |
| BW<sub>8</sub> | 1799 | 1194.87±3.55  | 150.84 | 605      | 1950.45 |
| BW<sub>10</sub> | 1998 | 1655.09±4.32  | 145.2 | 1205     | 2450    |
| BW<sub>12</sub> | 1799 | 2057.86±3.78  | 160.35 | 1480.9   | 2871.85 |
| BW<sub>14</sub> | 1720 | 2399.94±4.09  | 170   | 1770.9   | 3238.6  |
| BW<sub>16</sub> | 1693 | 2712.53±4.26  | 175.49 | 2055     | 3563.9  |

Table 2: Effect of rabbit lines (APRI and V lines) on body weight (g) at different weeks of age.

BW (4,6,8,10,12,14,16): Body weight at 4, 6, 8, 10, 12, 14, 16 weeks of age, respectively. *<sup>a</sup>-<sup>d</sup>: Means within columns with no common superscript differ significantly (α = 0.05); Values are least-squares means.

| Lines | BW<sub>4</sub> | BW<sub>6</sub> | BW<sub>8</sub> | BW<sub>10</sub> | BW<sub>12</sub> | BW<sub>14</sub> | BW<sub>16</sub> |
|-------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| APRI  | 511.17±4.07*<sup>a</sup> | 838.01±4.80*<sup>a</sup> | 1241.04±5.06*<sup>a</sup> | 1706.94±4.78* | 2138.62±5.12* | 2497.33±5.19* | 2818.19±5.12* |
| V     | 431.55±2.79*<sup>b</sup> | 747.23±3.53*<sup>b</sup> | 1147.07±4.45*<sup>b</sup> | 1601.41±4.20<sup>b</sup> | 1974.26±3.94<sup>b</sup> | 2300.49±4.19<sup>b</sup> | 2604.21±4.39<sup>b</sup> |

Table 3 shows the effects of age at weaning on body weight from 4 weeks up to 16wk of age. The mean weights at 4 weeks were similar between the different weaning ages due to the experimental design. The results indicate that at 6 weeks of age, the differences in body weight are economically important with significant differences were observed where body weight of the kits weaned at the age of more than 35 days was higher than rabbits weaned before 35d with a relevant difference (749.15). Moreover, the previous differences were increased until 8wk to be 987.9g per animal and the lowest weight achieved by the animals weaned at 28 days. At the end of study period reached to be more than 100g per animal favoring APRI line.

Moreover, the previous differences were increased until 8wk to be economically relevant differences of 68.32, 105.49 and 117.76g per animal respect WA<sub>1</sub>, WA<sub>2</sub> and WA<sub>3</sub> respectively. The negative effects of early weaning on body weight were compensated after 8 weeks of age where the observed differences in body weight were decreased between kits weaned in different ages and these differences were non-significant between the rabbits those weaned after 35 days. At 16 weeks, the only significant differences were observed between these animals weaned at a younger age (before 30) than those weaned after 30 days of age (at least 94g per kits).

Table 3: Effect of weaning age (WA) on body weight (g) at different weeks of age.

BW (4,6,8,10,12,14,16): Body weight at 4, 6, 8, 10, 12, 14, 16 weeks of age, respectively. *<sup>a</sup>-<sup>d</sup>: Means within columns with no common superscript differ significantly (α = 0.05).

| WA   | BW<sub>4</sub> | BW<sub>6</sub> | BW<sub>8</sub> | BW<sub>10</sub> | BW<sub>12</sub> | BW<sub>14</sub> | BW<sub>16</sub> |
|------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| WA<sub>1</sub> | 471.71±6.64*<sup>a</sup> | 730.78±7.62*<sup>a</sup> | 1109.73±7.95*<sup>a</sup> | 1580.6±8.42*<sup>a</sup> | 1998.13±8.96*<sup>a</sup> | 2316.6±10.12*<sup>a</sup> | 2637.99±10.77*<sup>a</sup> |
| WA<sub>2</sub> | 467.63±5.23<sup>a</sup> | 767.42±6.20<sup>a</sup> | 1177.51±7.07<sup>a</sup> | 1648.92±6.52<sup>a</sup> | 2053.67±7.96<sup>a</sup> | 2403.77±8.81<sup>a</sup> | 2731.2±9.28<sup>a</sup> |
| WA<sub>3</sub> | 475.81±4.17<sup>a</sup> | 821.95±4.52<sup>b</sup> | 1202.33±5.48<sup>b</sup> | 1686.09±5.07<sup>b</sup> | 2072.47±5.79<sup>b</sup> | 2422.1±5.66<sup>b</sup> | 2737.74±5.62<sup>b</sup> |
| WA<sub>4</sub> | 473.32±5.14<sup>a</sup> | 849.12±5.44<sup>a</sup> | 1264.83±5.75<sup>a</sup> | 1698.36±5.89<sup>a</sup> | 2101.74±6.47<sup>a</sup> | 2434.9±6.92<sup>a</sup> | 2734.81±7.02<sup>a</sup> |
Similar results observed by Gidenne [8] and Gallois et al. [10] where the live weight of rabbits weaned at early age remained lower than rabbit late weaned. Furthermore, El-Sabrout [20] and Kovács et al. [21] found that, at market age, rabbits weaned early (≤28) had significantly lower body weight at the age than those weaned later (35d). Moreover, MacNít [22] and Ferguson et al. [23] observed that the kits weaned at 14 days showed less growth and higher mortality than those weaned at 28 days. Where, the weaning early (less than 28 days) has shown a series of disorders of the kits related to the replacement from consumption of the milk to the granulated diet, obtaining contradictory results. The early weaning may be less problematic with intake of solid food where Piattoni et al. [24] found that kits weaned at early age did not ingest any feed for 1 or 2 days. Xiccato et al. [25] and Trocino et al. [26] comparing kits weaned at different ages (21, 25, 28 and 32 days), observed that kits weaned early (21 and 25 days) had a lower weight at 32 days (67g and 679g, respectively) than those weaned at 28 and 32 days (704 and 719g, respectively). Ako, Gabr et al. [27] reported that the weaning of young rabbits is a complex process with many impacts of dietary, environmental, and psychological stress, which resulting in an inconsistence weight gain, weight loss and possible total cessation of growth, in some instances death. Similar results have recently been obtained by Gidenne [8], although with higher mortality at the beginning of the fattening period (32 to 45 days) for the kits weaned early, at despite using a specific weaning diet (17.2 and 9.2% mortality for rabbits weaned at 23 and 32 days, respectively). Furthermore, late weaning has an advantage of reduced stress in young rabbit [28] because this stress could create some serious health problems within the young rabbits whose gut microbiota is still undeveloped where, with increasing age, the gut microbe population increases continuously. Also, previous results of Gallois et al. [29] showed the protective effect of milk intake in the young rabbit challenged with diseases of the intestine which are frequently seen during post-weaning period.

Genotype × weaning age interaction was studied for body weight of the different ages as shown in Table 4. There are clear indications for Genotype × weaning age interactions for body weight at the end of the fattening period (BW10) as well as the consecutive body weights. The superior body weights in APRI were achieved in when the weaning was carried out after 30 days while the higher weight for V line were when the weaning age was after 35d. So, as these results illustrate, it is a better to the rabbit breeder to wean the young rabbits of V line at late ages (at least 35 days of age) to obtain the highest levels of weight under Egyptian conditions where the animals of APRI line could be weaned after 30 days of age.

Table 4: Effect of rabbit lines (APRI and V lines) and weaning ages (WA) on body weight (g) during the fattening period.

| Strain | WA    | BW4 | BW6  | BW8  | BW10 | BW12 | BW14 | BW16 |
|--------|-------|-----|------|------|------|------|------|------|
| APRI   |       |     |      |      |      |      |      |      |
| WA     | 509.28±10.97a | 780.07±11.94a | 1172.84±12.11a | 1646.37±12.13a | 2090.09±12.45a | 2454.59±12.45a | 2779.22±12.30a |
| WA     | 505.87±7.30a  | 821.1±9.57a  | 1234.69±10.24a | 1713.38±8.99a  | 2154.10±10.36a | 2532.86±10.78a | 2865.32±11.13a |
| WA     | 518.74±5.58a  | 850.02±6.51a | 1247.5±7.24a  | 1730.5±6.30a  | 2124.33±8.40a  | 2470.91±8.23a  | 2797.58±7.17a  |
| WA     | 511.22±8.19a  | 892.1±8.06a  | 1305.02±8.41a | 1733.93±9.08a | 2181.35±8.46a | 2526.48±8.56a | 2827.16±8.80a |
| V line |       |     |      |      |      |      |      |      |
| WA     | 430.5±5.77a  | 676.75±7.50a | 1040.53±7.43a | 1508.49±9.21a | 1897.3±8.25a  | 2191.94±8.17a  | 2478.03±8.19a  |
| WA     | 428.07±6.60a | 711.9±5.95a | 1118.39±8.12a | 1582.27±7.27a | 1949.94±7.63a | 2274.67±7.01a | 2597.69±7.76a |
| WA     | 433.01±4.71a | 711.95±7.42a | 1139.28±7.83a | 1641.88±6.76a | 2040.66±6.32a | 2374.21±6.26a | 2677.96±6.47a |
| WA     | 434.57±4.99a | 798.95±5.60a | 1223.76±6.86a | 1662.02±6.66a | 2020.37±6.22a | 2344.56±6.61a | 2643.31±6.49a |

It seems that V line is affected by weaning age than APRI line where the differences between WA, and WA in V and APRI lines were 153.53 and 87.56, respectively. This may be attributed to that reason observed by El Nagar et al. [9] where V line in comparing with other Spanish lines, produced less milk so, later weaning is better for kits of V line. Moreover, El-Sabrout [20] observed that rabbits of the V line weaned later at (33d of age) had significantly higher body weight at the age of 63d (market age) than those weaned early (at 23 and 28d of age). Similar results were found by Marongiu [28] where they compared different rabbit genotypes and found that rabbits of California, where heavier than New Zealand White at the same weaning age which suggest that there is an interactive effect of genotype with weaning age. At the end of studying period, there is a clear line-weaning age interaction where the rabbits of APRI line in WA were the heaviest while the heaviest rabbits of V line were at WA.

Summary statistics for average daily gain traits are shown in Table 5 which takes into account the entire data. The phenotypic means of ADG (g/d) during the fattening period (until 10 weeks) and the rest of study period for the different lines are presented in Table 6. It should be noted that in the whole fattening period (ADG4-10), the ADG values at the initial period (4-6wk) were lower than the rest of fattening period and after the 6 weeks of age while the ADG increased to achieve the maximum growth rate during the period from 8-10 weeks of age. Line APRI was growing faster after fattening period, APRI lines gained weight per day significantly higher than V-line G in whole the period (10-16wk) with a relevant difference (2.26g/d per rabbit). Moreover, during the entire period from 4 to 16 weeks of age, the observed difference was 1.49g/d favoring APRI line.

Regarding the weaning age effects on ADG traits can be observed in Table 7. The pattern of weaning age effects can be observed in the first 2 weeks of growth was different from the pattern for the whole period. The ADG values in all weaning ages were lower than the rest of the whole period. For the whole fattening period (4-10wk), a negative effect of early weaning was significant where the weaned rabbits after 28d of age had a higher daily gain than rabbits weaned at 28d to be at least 1.72g/d per rabbit. At the end of the fattening period (ADG16), the inverse situation was found where the differences in
favor of rabbits weaned at late age were compensated, and, finally, ADG$_{10-12}$ for WA$_4$ was the highest. Under Egyptian conditions, for weaning age, it is better to wean the rabbit after 35 days while the weaning age of 28 days is not recommended under Egyptian conditions. After fattening period, the ADG values were similar; although these differences statically significant, but these values were not to pass 0.5g/d between WA$_4$, WA$_3$ and WA$_4$. The lowest growth rate was in rabbits weaned late and the highest ADG was carried out by rabbits in WA$_3$. This finding is very similar to that of Kovács et al. [21] & Cesari et al. [30] observed that the growth of rabbits weaned later was higher than that weaned early.

Table 5: Basic statistics (Number of observation (N), Mean, standard deviation (SD) and extreme values) for average daily gain traits (ADG g/d) between different ages (t$_1$-t$_2$) (weeks).

| Traits | N  | Mean       | SD   | Minimum | Maximum |
|--------|----|------------|------|---------|---------|
| ADG$_{4-8}$ | 1799 | 22.95±0.13 | 5.93 | 1.2    | 46.07   |
| ADG$_{6-8}$ | 1798 | 28.68±0.08 | 3.43 | 2.49   | 45.28   |
| ADG$_{8-10}$ | 1799 | 32.87±0.12 | 5.47 | 10.28  | 43.71   |
| ADG$_{10-12}$ | 1794 | 28.87±0.11 | 4.98 | 1.6    | 42.5    |
| ADG$_{12-14}$ | 1715 | 24.40±0.06 | 2.67 | 4.28   | 40.28   |
| ADG$_{14-16}$ | 1692 | 22.30±0.06 | 2.47 | 10     | 40.35   |
| ADG$_{16-18}$ | 1799 | 30.77±0.06 | 2.66 | 13.74  | 48.14   |
| ADG$_{18-20}$ | 1799 | 28.16±0.05 | 2.4  | 15.75  | 36.11   |
| ADG$_{20-22}$ | 1692 | 25.05±0.04 | 2   | 11.42  | 34.04   |
| ADG$_{22-24}$ | 1692 | 26.63±0.03 | 1.45 | 19.24  | 31.76   |

Table 6: Effect of rabbit lines (APRI and V lines) on average daily gain traits (ADG, g/d) between different ages (t$_1$-t$_2$) (weeks).

| Lines       | ADG$_{4-8}$ | ADG$_{6-8}$ | ADG$_{8-10}$ | ADG$_{10-12}$ | ADG$_{12-14}$ | ADG$_{14-16}$ | ADG$_{16-18}$ |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| APRI        | 23.34±0.16$^a$ | 28.79±0.08$^a$ | 33.27±0.14$^a$ | 31.03±0.06$^a$ | 30.98±0.12$^a$ | 25.52±0.06$^a$ | 22.81±0.09$^a$ |
| V Line      | 22.54±0.22$^b$ | 28.55±0.14$^b$ | 32.45±0.21$^b$ | 27.85±0.09$^b$ | 30.5±0.10$^a$ | 26.69±0.16$^a$ | 23.26±0.10$^a$ |

Table 7: Effect of weaning age (WA) on average daily gain traits (ADG, g/d) between different ages (t$_1$-t$_2$) (weeks).

| WA         | ADG$_{4-8}$ | ADG$_{6-8}$ | ADG$_{8-10}$ | ADG$_{10-12}$ | ADG$_{12-14}$ | ADG$_{14-16}$ | ADG$_{16-18}$ |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| WA$_1$     | 18.5±0.27$^a$ | 27.08±0.17$^a$ | 33.63±0.23$^a$ | 26.4±0.13$^a$ | 30.35±0.15$^a$ | 29.82±0.25$^a$ | 23.41±0.14$^a$ |
| WA$_2$     | 21.41±0.27$^a$ | 29.29±0.15$^a$ | 33.67±0.18$^a$ | 28.12±0.11$^a$ | 31.48±0.09$^a$ | 28.91±0.19$^a$ | 24.72±0.14$^a$ |
| WA$_3$     | 24.72±0.20$^b$ | 28.45±0.15$^b$ | 33.26±0.33$^b$ | 28.81±0.06$^b$ | 30.86±0.13$^b$ | 28.02±0.24$^b$ | 24.93±0.05$^b$ |
| WA$_4$     | 26.84±0.18$^b$ | 29.69±0.14$^b$ | 30.96±0.24$^b$ | 29.1±.08$^b$ | 30.33±0.11$^b$ | 28.81±0.23$^b$ | 24.43±0.12$^b$ |

Table 8 shows the line-weaning age interaction effects on ADG during the studied period. V line seems to be more affected by weaning age than APRI line. By contrast, line V had the lowest ADG, after 6 weeks of age, appeared during the early weaning with a significant difference. The highest values were obtained in WA$_1$ and WA$_2$ for APRI line while for V line the highest values were for WA3 and WA4.

The ADG from 4 to 16wk of APRI line were less relevant values while, for the same period, the differences of V line were more relevant [31-33].
Table 8: Effects of rabbit lines (APRI and V lines) and weaning ages (WA) on average daily gain traits (ADG, g/d) between different ages (1-14, 16 weeks).

| Lines | WA | ADG\(_{1-6}\) | ADG\(_{6-10}\) | ADG\(_{10-12}\) | ADG\(_{12-14}\) | ADG\(_{14-16}\) | ADG\(_{16}\) |
|-------|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| APRI  | W\(_A\) | 19.3±0.21\(^a\) | 20.09±0.11\(^a\) | 25.2±0.13\(^a\) | 27.07±0.08\(^a\) | 28.3±0.10\(^a\) | 29.8±0.12\(^a\) | 31.6±0.14\(^a\) |
|       | W\(_A\) | 20.5±0.30\(^b\) | 29.54±0.15\(^b\) | 31.8±0.13\(^b\) | 33.3±0.10\(^b\) | 34.5±0.13\(^b\) | 36.7±0.14\(^b\) | 38.9±0.15\(^b\) |
|       | W\(_A\) | 23.6±0.20\(^b\) | 29.39±0.20\(^b\) | 32.5±0.34\(^b\) | 35.8±0.08\(^b\) | 38.5±0.10\(^b\) | 41.2±0.12\(^b\) | 44.4±0.15\(^b\) |
|       | V\(_A\) | 27.6±0.28\(^c\) | 29.05±0.16\(^c\) | 30.6±0.24\(^c\) | 31.9±0.13\(^c\) | 32.9±0.16\(^c\) | 35.1±0.14\(^c\) | 37.3±0.16\(^c\) |
|       | W\(_A\) | 17.5±0.51\(^d\) | 25.98±0.31\(^d\) | 25.6±0.25\(^d\) | 29.7±0.30\(^d\) | 30.7±0.32\(^d\) | 32.8±0.34\(^d\) | 35.0±0.36\(^d\) |
|       | W\(_A\) | 20.27±0.44\(^d\) | 29.03±0.26\(^d\) | 31.3±0.20\(^d\) | 37.4±0.19\(^d\) | 41.8±0.18\(^d\) | 46.2±0.17\(^d\) | 51.3±0.16\(^d\) |
|       | W\(_A\) | 25.78±0.33\(^d\) | 28.51±0.23\(^d\) | 32.0±0.56\(^d\) | 37.8±0.10\(^d\) | 43.2±0.24\(^d\) | 48.7±0.34\(^d\) | 54.1±0.34\(^d\) |
|       | W\(_A\) | 26.02±0.24\(^d\) | 30.34±0.23\(^d\) | 31.3±0.41\(^d\) | 29.22±0.10\(^d\) | 30.82±0.16\(^d\) | 35.5±0.29\(^d\) | 41.0±0.12\(^d\) |

CONCLUSION

Under Egyptian conditions, the results give a good hope of the APRI line, important differences for growth traits were detected favoring APRI line than V line. The early weaning had negative effects in growth traits during the fattening period, but these negative effects were compensated after 8 weeks of age. The early weaning (before 28d) is not recommended for Egyptian rabbit. Clear indications of Genotype x weaning age (GxWA) interactions were observed for growth traits where V line is affected by weaning age than APRI line. It is recommended to wean the young rabbit of APRI between 29-35 days while in V line is recommended the weaning age after 35 days.

AUTHOR CONTRIBUTIONS

Conceptualization, MR, Kh HE, and ITE; methodology, MR. LMR IT&E and AME; software, MR. LMR AAE and Kh HE formal analysis, MR. LMR I&E and AME investigation MR. Kh HE and ITE; data curation, MR., Kh HE LMR IT&E, and ITE; writing-original draft preparation, ITE. LMR and MR writing-review and editing, MR. Kh HE LMR and AME. All authors have read and agreed to the published version of the manuscript.

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