Global Veterinaria 20 (1): 01-05, 2018
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2018.01.05

# Effect of Stocking Density on Growth Performance, Carcass Traits and Some Hematological Parameters of New Zealand White Rabbits

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**Abstract:** Seventy fives of New Zealand White (NZW) rabbits weaned at 4-weeks of age and weigh (545±3.4 g) were used in the present study to investigate the effect of stocking density on their growth performance, carcass traits and some blood parameters. Rabbits were randomly assigned to three stocking densities: 12, 20 and 28 rabbits/$m^2$ (Represented 3, 5 and 7 rabbits/cage of 2500 $cm^2$; respectively). Rabbits housed at 12 rabbits/$m^2$ had the lowest feed conversion ratio (P=0.053), the highest average daily feed intake (P=0.001), final live body weight (P=0.003) and average daily weight gain (P=0.001). At 13-week of age, concentration of hemoglobin (g $dL^{-1}$), packed cell volume (%), the mean corpuscular volume (fl) and lymphocytes % were significantly (P=0.001) high for rabbits stocked at 12 rabbits/$m^2$. Rabbits kept at 28 rabbits/$m^2$ revealed the highest platelet count and white blood cell count as compared to other groups. The mean corpuscular hemoglobin (pg $cell^{-1}$), Mean corpuscular hemoglobin concentration (g $dL^{-1}$) and red blood cell count were not affected by stocking density. The stocking density had a significant effect on hot carcass weight, dressing out percentage, liver weight and kidney in addition to head percentage. While the other traits were not affected by the stocking density. Rabbits stocked at 12 rabbits/$m^2$ had the highest hot carcass weight (1418 g), dressing out percentage (66.47%), liver weight (70.65 g) and the lowest kidney and head percentages (0.51 and 6.38%, respectively). It could be concluded that increasing stocking density up to (20 rabbits/$m^2$) induce stressful condition in term of increasing WBCs and platelet counts and some disturbance in performance and carcass traits of NZW rabbits.

**Key words:** Rabbits · Stocking Density · Carcass Traits · Growth Performance · Blood Parameter

## INTRODUCTION

Rabbits are small and quite animals, their meat is nutritious (very rich in protein and low in fat, cholesterol and calories), their litters are large with short generation intervals and they are able to extract protein from forage so that they have advantages over the other livestock [1]. Also, they are used as show and laboratory animals. There are many factor should be considered to achieve the ideal rabbit production such as suitable environmental conditions (Proper cage size and location, temperature, humidity and ventilation), hygiene and adequate nutrition to minimize the stress effect [2]. The suitable cage size should permit each growing rabbit to stretch along one side of the cage and sit up right at all age intervals [3]. Council of Europe Appendix ETS 123 [4] recommended that rabbits less than 10 weeks of age should be housed in cage with a minimum floor area of 1200 $cm^2$ to avoid disturbance in social behavior. Increasing stocking density in rabbit house worsens their productivity (Decrease feed intake and body weight gain) [5, 6]. Overcrowding lead to change in alimentary and locomotory behavior of growing rabbits which affect their carcass traits [7, 8]. Rearing 15-16 rabbits/$m^2$ (39-40 kg/$m^2$) at the end of growing period is considered the threshold for the compatible expression of normal behaviors of caged rabbits [9]. The aim of the current research was to detect the effect of stocking density on growth performance, carcass traits and some blood parameters of NZW rabbits.

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## MATERIALS AND METHODS

The present work was conducted at experimental unit belong to Animal Wealth Development Department, Faculty of Veterinary Medicine, Zagazig University. Sharkia- Egypt during the period from the first of April to end of May 2017. This work was performed in accordance with Animal Ethics Committee guidelines of Zagazig University.

### Experimental Animals

**Housing and Diet:** Seventy five 4-week old unsexed (NZW) rabbits were randomly allotted to three stocking density of 3, 5 and 7 rabbits/cage (Represented 12, 20 and 28 rabbits/$m^2$; respectively). Each treatment group was replicated five times. The experimental animals were obtained from a commercial farm. From weaning till 13 weeks of age, all rabbits were housed in galvanized wire cages (50x50x48 cm) fitted with feeder (30 cm) and automatic nipple drinkers. Cages were set in a well-ventilated building. The environmental temperature ranged from 28-33°C, photoperiod was continuous and relative humidity ranged from 60 to 75% throughout the experimental period. Rabbits in all treatment groups were fed ad libitum the pelletized diet which contained 18 % crude protein, 2.5% crude fat, 2651 kcal/kg digestible energy and 12.65% crude fiber.

**Growth Performance:** Initial and final live body weight (LBW) was recorded individually for each rabbit. The average daily feed intake, average daily weight gain and feed conversion ratio(FCR) were recorded over a period (5-13 weeks of age).Feed conversion ratio was estimated as (Feed g/gain g).

**Carcass Traits:** At the end of the experimental period (13 weeks of age), 10 rabbits from each treatment were randomly taken and fasted for 12hr then slaughtered according to Islamic method with some modification and we follow recommendation of world rabbit science association (WRSA) according to Blasco and Ouhayoun [10]. After complete bleeding, fur, viscera's and tail were removed then the carcass and some its components were weighed (Liver, kidney, heart and head). Percentages of previously mentioned organs relative to live body weight were calculated. Dressing out% was also estimated (Carcass weight/live body weight before slaughter).

**Blood Sampling:** Blood samples were collected from five rabbits per each treatment at end of experimental period (13 weeks of age) during the slaughtering in EDTA tubes and were used for hematological analysis to measure red blood cell count (RBCs), white blood cell count (WBCs), platelets counts, concentration of hemoglobin (Hb), Lymphocytes percentage, packed cell volume (PCV), mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH) and Mean corpuscular hemoglobin concentration (MCHC), all these parameters were measured in whole blood using hematology analyzer (HB7021).

**Statistical Analysis:** Data were analyzed using one-way analysis of variance (ANOVA) procedure of the Statistical Package for Social Sciences version 21.0 (SPSS for Windows 21.0, Inc., Chicago, IL, USA). The post hoc comparisons of means were equal variance assumed and carried out with Duncan's multiple range tests (DMRT). Results were recorded as mean ± standard errors (SE), the value of $P<0.05$ was used to indicate statistical significance. The Statistical Model was:

$$Yij = \mu + si + \varepsilon ij$$

where;
Yij: The response variable.
μ: Overall mean effect.
si: Fixed effect of $i^{th}$ stocking density.
εijk: Random error.

## RESULTS

**Growth Performance:** Stocking density had a significant effect on growth performance parameters. Initial live body weight was similar in all groups. Rabbits housed at 12 rabbits/$m^2$ had the heaviest final LBW (2210 g), the highest average daily weight gain and feed intake (26.73 and 82.6 g; respectively) with the lowest FCR (3.12) while rabbits housed at 28 rabbits/$m^2$ had the lowest weight, gain and feed intake with highest FCR (Table 1).

**Carcass Traits:** Results of carcass traits at 13-weeks of age as affected by stocking density are presented in (Table 2). The stocking density had a significant effect on hot carcass weight, dressing out percentage, liver weight, kidney and head percentage. Rabbits stocked at low stocking rate (12 rabbits/$m^2$) had the highest hot carcass weight (1418 g; P=0.003), dressing out percentage (66.47%; P=02), liver weight (70.65 g; P=0.02) and lower kidney (0.51%; P=0.oo3) and head percentage (6.38%; P=0.003).

Table 1: Effect of stocking density on growth performance of New Zealand White rabbits

| | Stocking density (Rabbits/m$^2$) | | | |
|---|---|---|---|---|
| Variable | 12 rabbits/m$^2$ | 20 rabbits/m$^2$ | 28 rabbits/m$^2$ | P-value |
| Initial LBW at 5$^{th}$wk (g) | 714.00±23.75 | 651.00±22.54 | 656.37±12.33 | 0.082 |
| Final LBW at 13$^{th}$wk (g) | 2210.87$^{a}$±32.51 | 2014.68$^{b}$±36.29 | 1866.46$^{c}$±30.83 | 0.003 |
| Average daily weight gain (g) | 26.73$^{a}$±0.69 | 25.14$^{a}$±0.70 | 21.61$^{b}$±0.44 | 0.001 |
| Average daily feed intake (g) | 82.60$^{a}$ ±0.44 | 75.54$^{b}$ ±0.54 | 72.68$^{c}$ ±0.38 | 0.001 |
| Feed conversion ratio | 3.12$^{b}$±0.08 | 3.18$^{ab}$±0.11 | 3.44$^{a}$±0.09 | 0.053 |

Means within the same row having different superscript letters are significantly different at (P<0.05).
LBW: live body weight.

Table 2. Effect of stocking density on carcass traits of New Zealand White rabbits at 13 weeks of age

| | Stocking density (rabbits/m$^2$) | | | |
|---|---|---|---|---|
| Variable | 12 rabbits/m$^2$ | 20 rabbits/m$^2$ | 28 rabbits/m$^2$ | P-value |
| Hot carcass weight (g) | 1418$^{a}$±52.53 | 1197$^{bc}$±31.80 | 1086$^{c}$±56.92 | 0.003 |
| Dressing out (%) | 66.42$^{a}$±2.41 | 60.83$^{b}$±0.99 | 60.18$^{b}$±1.08 | 0.022 |
| Liver weight (g) | 70.65$^{a}$±4.44 | 57.94$^{bc}$±2.66 | 45.59$^{c}$±4.81 | 0.020 |
| Kidney weight (g) | 8.64±1.99 | 11.64±1.21 | 16.72±2.17 | 0.120 |
| Heart weight (g) | 6.89±1.56 | 6.34±0.95 | 7.08±1.69 | 0.857 |
| Head weight (g) | 136.40±4.52 | 130.80±2.73 | 127.00±4.89 | 0.502 |
| Liver (%) | 3.04±0.14 | 2.94±0.16 | 3.02±0.18 | 0.896 |
| Kidney (%) | 0.51$^{b}$±0.07 | 0.60$^{b}$±0.05 | 0.83$^{a}$±0.06 | 0.003 |
| Heart (%) | 0.33±0.05 | 0.33±0.04 | 0.40±0.05 | 0.470 |
| Head (%) | 6.38$^{b}$±0.13 | 6.71$^{b}$±0.14 | 7.37$^{a}$±0.26 | 0.003 |

Means within the same row having different superscript letters are significantly different at (P<0.05).

Table 3: Effect of stocking density on hematological parameters of New Zealand White rabbits at 13 weeks of age

| | Stocking density (rabbits/m$^2$) | | | |
|---|---|---|---|---|
| Variable | 12 rabbits/m$^2$ | 20 rabbits/m$^2$ | 28 rabbits/m$^2$ | P-value |
| Hb (g dL$^{-1}$) | 13.21$^{a}$±0.12 | 12.13$^{b}$±0.07 | 13.10$^{a}$±0.09 | 0.001 |
| PCV (%) | 35.27$^{a}$±0.13 | 34.37$^{b}$±0.18 | 32.43$^{c}$±0.26 | 0.001 |
| MCV (fl) | 64.34$^{a}$±0.04 | 62.69$^{b}$±0.15 | 61.12$^{c}$±0.12 | 0.001 |
| MCH (pg cell$^{-1}$) | 23.90±0.06 | 23.34±0.33 | 23.37±0.13 | 0.179 |
| MCHC(g dL$^{-1}$) | 37.63±0.09 | 37.45±0.29 | 37.10±0.17 | 0.245 |
| RBC (x10$^6$ mm$^{-3}$) | 5.69±0.15 | 5.29±0.19 | 5.35±0.22 | 0.339 |
| Platelet count (x10$^3$ mm$^{-2}$) | 56.37$^{c}$±0.32 | 145.43$^{b}$±0.72 | 241.67$^{a}$±1.20 | 0.001 |
| WBC (x10$^3$ mm$^{-3}$) | 7.02$^{c}$±0.26 | 8.27$^{b}$±0.07 | 9.25$^{a}$±0.33 | 0.002 |
| Lymphocytes (%) | 70.54$^{a}$±0.53 | 60.36$^{b}$±0.36 | 51.80$^{c}$±0.42 | 0.001 |

Means within the same row having different superscript letters are significantly different at (P<0.05).
Hb: concentration of hemoglobin; PCV: packed cell volume; MCV: mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration RBC: red blood cell count; WBC: white blood cell count

**Blood Parameters:** The hematological values of Hb, PCV, MCV and lymphocytes were significantly (P<0.001) high for rabbits stocked at 12 rabbits/m$^2$, while MCH, MCHC and RBCs were not affected by stocking density. Rabbits kept at 28 rabbits/m$^2$ revealed the highest platelet count (241.67x10$^3$ mm$^{-2}$) and WBCs count (9.25x10$^5$ mm$^{-3}$) as compared with the other groups (Table 3).

## DISCUSSION

Stocking density had a significant effect on growth performance of NZW rabbits in the current study. These results are consistent with those reported previously by Abd El-Monem *et al*. [5], Kalaba [11], El-Samra *et al*. [12] and Bhattacharjya *et al*. [13]. Increasing the density from 6 to 12, 18 and 24 rabbits/m$^2$ led to decreasing feed intake and average daily gain by 0.80 and 0.20 g; respectively [6]. Rabbits stocked at 12 rabbit/m$^2$ had higher feed intake ( 140 g/d) than those stocked at 16 rabbit/m$^2$ (134 g/d) [14] but controversy results was obtained by Garcia *et al*. [15] and Neto *et al*. [16] who noted that the stocking density had no effect on live body weight and gain. Feed intake and weight gain wasn't affected by stocking density of 4 and 10 rabbits/m$^2$[17]. Stocking density had no effect on BWG and FCR [18]. A reduction in weight gain at higher density may be attributed to lower feed intake due to overcrowding.

In the present study the stocking of cage had bad effect on carcass traits. Similar results were reported by Abd El-Monem *et al*. [5] and Trocino *et al*. [14]. In partial accordance with the present results, El-Samra *et al*. [12] observed that there was non- significant (P>0.05) effect of cage density on carcass weight of rabbits under the varying four stocking densities (1, 2, 3 and 4 rabbits/cage), except liver weight was higher in group having 2 rabbits/cage (0.083 g) than other groups having 3, 4 and 1 rabbits/cage (0.048, 0.052 and 0.062 g; respectively). Similarly, kidney was higher in group having 2 rabbit/cage (0.020 g) than other groups having 3, 4 and 1 rabbits/cage (0.011, 0.017 and 0.015 g; respectively). On the other hand, a non-significant effect of stocking density on carcass traits reported previously by Volek *et al*. [17], Dorra *et al*. [18], Villalobos *et al*. [19] and Yakubu *et al*. [20].

In the present result some blood parameters was significantly affected by stocking density such as Hb, PCV, MCV and lymphocytes were significantly were higher in rabbits stocked at 12 rabbits/$m^2$, while MCH, MCHC and RBCs were not affected by stocking density. In partial accordance with present results, Yakubu *et al*. [21] found higher average PVC, Hb, RBC and MCV in rabbits stocked at 10 and 14.3 compared to their counterparts raised at 20 and 25 rabbits/$m^2$. Kalaba [11] noted that rabbits kept at 8 rabbits/$m^2$ had the highest (P<0.05) value of Hb, RBC, lymphocytes %, PCV % and MCV. MCH and MCHC were the highest (P<0.05) in rabbits stocked at 4 rabbits/$m^2$. On the other hand, De la Fuente *et al.* [22] reported that PCV was similar in rabbits stocked at 8 and 12 rabbits per cage. In the present work, rabbits kept at 28 rabbits/$m^2$ had the highest platelet and WBCs counts as compared with the other groups. This increase could be indicative of stress which elicits as a defense response. In harmony with the present results, Kalaba [11] found that rabbits housed at 16 rabbits/$m^2$ had the highest (P<0.05) WBCs than those kept at 8, 12 and 16 rabbits/$m^2$. Also, El-Samra *et al*. [12] observed that rabbits stocked at 4 rabbits/cage had significantly (P<0.05) the highest WBCs ($16.43x10^3/mm^3$) compared with those having 1, 2 and 3 rabbits/cage. In contrast, there was non- significant difference in WBCs in rabbits kept under a stocking density of 10, 14.3, 20 and 25 rabbits/$m^2$ [21].

In conclusion, increasing number of rabbits above 20 rabbits/$m^2$ worsens growth performance, carcass traits and change in some blood parameters such as an increase in platelet and WBCs counts.

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