



## The effects of bee pollen on performance and economic efficiency of New Zealand White rabbits reared under high stocking density

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### ABSTRACT

This study aimed to Test the hypothesis supplementation with bee pollen (BP), as a beneficial feed additive, could alleviate the detrimental effects of overcrowding on the productive and economic efficiency in growing rabbits. A total of eighty 30 day-old male NZW rabbits (561.7±8.3 g) were randomly allocated into to four groups (each of which replicated four times), of two stocking density 8 and 24 /m<sup>2</sup>. This corresponds to 2, 6 rabbits per cage. Groups were arranged as follow: control G1 (LSD; 2 rabbits/cage and no supplementation), G2(HSD; 6 rabbits/cage and no supplementation),G3(HSD-BP250; 6 rabbits/cage and 250mg/kg(BW) BP given orally), G4(HSD- BP500; 6 rabbits/cage and 500mg/kg( BW) BP given orally). Rabbits in HSD-BP500 group had significantly higher BW, BWG, lower FI and better FCR and FE than HSD-BP250and HSD groups. Rabbits in HSD-BP500 had significantly higher dressing out % and carcass weight than HSD- BP250and HSD groups. Significant increase in values of RBCs counts, Hb, PCV, WBCs, lymphocyte, heterophils % and decreased H/L ratio were detected in HSD-BP500 group compared to HSD and HSD-BP250 groups.. while, values of MCV and MCH were not significantly (P > 0.01) different among groups. The highest values of total protein, globulin and the lowest serum urea, creatinine, cholesterol, triglycerides, ALT and AST were observed in HSD-BP500 group. The highest values of total and net revenue and the best economical efficacy were obtained in HSD-BP500 group. Conclusively, from the obtained results It can be concluded that the supplementation of bee pollen at dose of 500mg/kg BW improved the performance parameters of NZW rabbits and increased farm profitability.

**Keywords:** Bee pollen, rabbits, stocking density, performance, carcass traits, economic efficiency.

### 1. Introduction

In recent years, commercial rabbit production has been gaining much attention due to their rapid growth, small body size, as well high prolificacy and meat production. Therefore, rabbits can convert about 20% of the protein in their diet to meat, which is higher (8-12%) than beef (Basavaraj et al., 2011). The digestive system of the rabbits has a complex physiology due to both the caecotrophy and microbial fermentations in the caecum, that made this species susceptible to the enteric diseases, particularly after weaning. For this, the antibiotics are often used in the rabbit farms and zinc bacitracin (ZnB) is the most used antibiotic to reduce mortality in growing rabbits (Bovera et al., 2010).

The ban of AGP (antibiotic growth promoters) in animal production established by the European Unit poses a serious challenge for rabbit meat producers. Thus, there have been several studies in which different feed additives were evaluated as an alternative to antibiotics (Attia et al., 2011).

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One of the regarded candidates in natural products is bee pollen (BP). BP is a natural material generated by pollen of flowering plants, mixed with the bee digestive secretion enzymes and nectar and packed by the honeybees. Besides, BP is a rich source of many components such as protein (25%), essential amino acids, Lipids (6%), containing more than about 51% polyunsaturated fatty acids) 13% linoleic acids, 20% palmitic and 39% linolenic), more than 28 minerals, 12 vitamins, 11 enzymes or coenzymes, carbohydrates (35%–61%) (11 sugar types mainly sucrose, glucose and fructose), carotenoids, phenolic and flavonoids compounds (Xu et al., 2009). However, bee pollen is varying in its chemical composition depending on the flora present in various climate zones (Nogueira et al., 2012).

Bee pollen has been used as medicine and food supplement in animal rations owing to their growth-promoting potential, antioxidant capacity, and immunostimulating properties (Liu et al., 2010). Furthermore, the presence of phenolic compounds, especially flavonoids, have been reported to possess antimicrobial, anti-inflammatory, anti-carcinogenic, antiproliferative, and hepatoprotective properties (Cocan et al., 2005; Hamamoto et al., 2006; Yamaguchi et al., 2006; Pascoal et al., 2014). Also, application of BP as feed supplement has been proposed to ameliorate various diseases such as bronchitis, dermatitis and allergies (Martín-Muñoz et al., 2010). The positive effects of bee pollen on rabbit health have already been reported, but to the best of our knowledge, no information is available concerning the potential effects of bee pollen under the stress caused by overcrowding. So the aim of this study is to Tested the hypothesis supplementation with bee pollen, as a beneficial feed additive, could alleviate the detrimental effects of overcrowding on the productive and economic efficiency in growing rabbits.

### 2. Material and methods

This work was conducted at the rabbit farm, Faculty of Veterinary Medicine, Zagazig University, Sharkia province, Egypt. The experiment was conducted in compliance with the ethical standards and regulations set out by the Faculty of Veterinary Medicine's Local Laboratory Animals Care Committee, Zagazig University. The experimental procedure had been approved by the institutional ethics committee (Approval No. ANWD 206).

#### 2.1. Animals, management and experimental design

A total of eighty 30 day-old male NZW rabbits (561.7±8.3 g) were randomly allocated into to four groups ( each of which replicated four times), of two stocking density 8 and 24 /m<sup>2</sup>.

This corresponds to 2, 6 rabbits per cage.

The experimental design was factorial 2 x 3, whereas two stocking density (2and 6 rabbit/ cage) and three levels of bee pollen (0, 250 and 500 mg/kg Bwt ). So, four experimental treatments were as follow:

1-G1: low Stocking density of 2 rabbits/cage and rabbits fed basal diet without any supplementation (LSD)

2-G2: higher Stocking density of 6 rabbit per cage and rabbits fed basal diet without any supplementation (HSD).

3-G3: higher Stocking density of 6 rabbit per cage and rabbits fed basal diet supplemented with bee pollen at 250 mg/kg BW given orally (HSD-BP250).

4-G4: higher Stocking density of 6 rabbits per cage and rabbits fed basal diet supplemented with bee pollen at 500 mg/kg BW given orally (HSD-BP500).

The BP is given to rabbits twice weekly as a water suspension using an insulin syringe (2ml dose). For each oral administration, a fresh suspension of bee pollen in the water was made and each animal received the appropriate quantity of BP (250 mg /kg BW for G3 and 500 mg/kg BW for G4) by insulin syringe. The control groups ( G1 and G2) received the same quantity of water, but without BP. The oral administration was done in the early morning. The experimental procedures continued for 7 consecutive weeks (from week 4 to week 11 of age).

All rabbits were kept in the same building and placed in galvanized wire cages (40 high x 50 width x 50 cm length), with an automatic system of nipple drinkers. Throughout the experiment, the lighting schedule was kept at 16 h of light and 8 h of darkness; the ambient temperature was adjusted at  $21 \pm 2.5^\circ\text{C}$  and the relative humidity was about  $65 \pm 5\%$ . All diets were given in pelleted form, and the basal diet was formulated to satisfy the nutrient requirements as per NRC recommendations (1977; Table 1). The animals had an ad libitum excess to feed and water.

## 2.2. Performance traits

Rabbits' body weights were measured at the beginning (30 day- old ; initial weight) and then they were weighed weekly till the end of experimental trial (w 11; final weight), and body weight gain (BWG) was estimated as the difference between final body weight and initial body weight. Feed intake (FI) was measured over this period per cage, feed conversion rate (FCR) was calculated for as the ratio of feed (g) to weight gain (g) and Feed efficiency also calculated as the ratio of weight gain to feed intake (g) to . Mortality rate was recorded daily (the dead rabbit is replaced by new one) throughout the experimental period. The BWG, FI and feed intake to gain ratio data were corrected for dead rabbits in each cage.

## 2.3. Carcass traits

At the end of the trial, four rabbits per group with an average body weight of  $1800 \pm 50$  g were chosen for blood sampling and carcass assessment, before which they were fasted for 12 h. All rabbits were weighed (SW), slaughtered according to Islamic method, and then the skin, gastrointestinal tract, urinary bladder, and distal leg section were excised. Hot carcasses (with head, thoracic cage organs, liver, kidneys, perirenal fat) were weighed; then chilled at  $4^\circ\text{C}$  for 24 h. The chilled carcasses were weighed (CCW) and the head, thoracic organs, liver, and kidneys were eliminated to get the reference carcasses (RCW). The dressing out (CCW as percentage of SW) and the proportion of head, liver, kidney, and carcass parts (fore, mid, and hind parts) to either CCW or RCW were evaluated as required.

## 2.4. Hematological and serum biochemical parameters

Blood samples ( $n=4/\text{group}$ ) were collected during slaughter process, one part was transferred to a vacutainer tube containing EDTA as an anticoagulant for hematological evaluation and the other part was transferred to a gel activator tube for serum separation (3000 rpm; 15 min;  $4^\circ\text{C}$ ). Red blood cells count (RBC's), white blood cells count (WBC's), hemoglobin concentration (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), and mean cell hemoglobin (MCH) of the whole blood samples were measured using a Hema Screen 18 automated hematology analyzer (Hospitex Diagnostics, Sesto Fiorentino, Italy), whereas differential leukocyte counts (lymphocytes and heterophils) were calculated manually according to Dacie and Lewis (1991).

Serum total protein, albumin, cholesterol, triglycerides, aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea, and creatinine were determined using commercially diagnostic kits (Diamond Diagnostics, Holliston, MA, USA) as per the manufacturer's instructions.

## 2.5. Economic feasibility measurements

Partial budgeting technique was utilized to evaluate the economic impact of stocking density as follow:

Total feed cost = Total feed intake per rabbit x cost of one kg diet.

Total cost was calculated by considering feeding cost as well as the expense of experimental rabbits, bee pollen, labor, veterinary services and other miscellaneous expenditure.

Total revenue = rabbit live body weight x price of kg live BW. Net revenue = total revenue – total cost

Cost-benefit ratio = Total cost/total revenue Economic efficiency = total revenue/ Total cost

## 2.5. Statistical analysis

Data were analyzed using one way analysis of variance (ANOVA) procedures of SAS 9.2 (SAS Inst. Inc., Cary, NC, USA), with cage replicates treated as experimental units. The significant differences among mean values were determined using the Bonferroni test, where  $P < 0.05$  was considered significant.

## 3. Results and Discussion

### 3.1. Pathogenicity Index—ICPI

Results in table (2) revealed that performance traits were significantly affected by bee pollen. rabbits at HSD-BP500 group had higher BW ,BWG ,lower FI and better FCR and FE than HSD and HSD- BP250 groups . This increase in body weight and weight gain could be attributed to improving their crude protein digestibility, which led to improving nutrient and protein utilization and resulting in higher protein anabolism and intestinal absorptive capacity. These positive improvements could be due to the nutritive value of the bee-pollen as a rich source of protein (29.94%), essential amino acids (e.g., Leucine, Alanine, Glutamine and lysine), fat (4.35%), carbohydrates (61.71%) and minerals (e.g., Na, Ca, Mg, P, Zn, Mn and Fe). These results agree with those of Aboughaba (2018) in Sinai cocksers and Abdel-Hamid and El-Tarabany (2019) in growing rabbits. Also, Zeedan et al. (2017) noted that the supplementation of growing rabbits with BP at dose of 200, 500, 700 mg /kg BW significantly ( $P \leq 0.05$ ) increased final body weight and total weight gain than control groups. Contrary, the findings of Dias et al., (2013) showed that BP supplementation of growing rabbits was not sufficient to improve the performance from weaning up to slaughter age.

the decreased FI and better FCR and FE in rabbits treated with higher dose of bee pollen (500 mg/kg BW) may suggest that the use BP in diets for growing rabbits might enhance the growth of lactic acid fermenting bacteria in the gut and improved the food digestibility and utilization of ammonia due to BP supplementation also The decreased feed intake in rabbits supplemented with higher dose of BP could be explained by the increase in nutrients such as minerals and vitamins could accelerate nutrients metabolism and increase energy digestibility. These results agree with the findings of Zeedan et al. (2017) for rabbits ,Soha and El-Rayes (2016) in broiler chicken and Babaei et al. (2016) for Japanese quails. El-Hanoun et al. (2007) indicated that the feed efficiency was improved of growing NZW rabbits supplemented with low doses (250) and high doses (500) mg BP per kg BW compared to control group during winter and summer seasons from weaning up to mature age. On contrary, Haščík et al. (2012) indicated that bee-pollen increased feed intake of broiler chickens.

Data regarding characteristics of the carcass are presented in Table 3, showed that No significant differences ( $P > 0.05$ ) were observed between groups with respect to the percentages of skin, full intestine, head, and carcass parts (fore, mid, and hind parts). However, a significant difference between groups ( $P < 0.001$ ) was observed in other carcass traits. the rabbits treated with BP had the heaviest mean carcass characteristics than the control groups ( LSD and HSD groups ). the best values of slaughter weight, chilled carcass weight and reference carcass weight was observed in HSD-BP500 group compared to HSD and HSD-BP250 groups.

These results are in agreement with those of Habiba et al. (2015) demonstrated that the growing rabbits supplemented with BP had significantly higher carcass dressing weight (16.7%) and carcass percentage (9.5%) than control group. Similar result obtained by Haščík et al. (2012) and El-Neney and El-Kholy (2014) and Habiba et al.(2015). Zeedan et al. (2017) proved that the rabbits treated with BP had the heaviest mean carcass characteristics than the control group. In contrast, the findings of Dias et al. (2013) and Attia et al. (2014) showed that the carcass yield of rabbits was not influenced by BP supplementation.

Our study showed that the hematological values of MCV and MCH were not significantly ( $P > 0.01$ ) different among groups. However, significant increase in values of RBCs counts, Hb, PCV, WBCs, lymphocyte, heterophils % and decreased H/L ratio were detected in HSD-BP500

group compared to HSD and HSD-BP250 groups. The positive impact on pcv, Hb and RBCs values could be due to minerals such as Fe and Cu contained in bee-pollen and vitamins such as folic acid and vitamin C. These minerals and vitamins have a role in RBCs formation and maturation. The increasing of WBCs, lymphocyte and heterophils % in a certain level is a good indicator of increasing the immunity efficiency and this may be attributed to the presence of minerals, antioxidant which present in flavonoids and vitamins in bee-pollen which have a role in enhancing immune system. These results were consistent with Babaei et al. (2016) in Japanese quails and Aboughaba (2018) in cockers. Also, Farag and EL-Rayes (2016) showed that the The values of PCV, Hb, RBCs, WBCs, H and L in chicks fed on the basal diet were significantly lower than that of chicks fed bee-pollen at any level in their diets, while the highest value of H/L was obtained in birds fed control diet.

Data regarding serum biochemical parameters are presented in Table 5 revealed that, all biochemical parameters studied were affected significantly by dietary bee-pollen supplementation expect albumin concentration. The highest values of total protein, globulin and the lowest serum urea, creatinine, cholesterol, triglycerides, ALT and AST were observed in HSD-BP500 group compared to HSD and HSD-BP250 groups.

The increased blood proteins in rabbits received a high dose of BP (500mg/kg BW) may be associated with improvement of crude protein digestibility as well as to the high level and good quality of protein contents in bee pollen.

The decreased plasma urea and creatinine with increasing BP levels may be an interaction between BP and the activity of some microbial strains. It can be hypothesized that BP has interfered to some extent on decreasing the harmful bacteria and increase protein synthesis with a consequent reduction in ammonia production and/or utilization. The decreased triglycerides and cholesterol values may be due to unsaturated fatty acids in BP as oleic, linoleic and linolenic (14.20, 10.14 and 16.64%, respectively), that play role in inhibits accumulation of lipid peroxidation product.

The decreased levels of AST and ALT suggested that bee-pollen improved liver function and reduced liver damage. The protective effect of bee-pollen upon liver could be due to antioxidant contents of some flavonoids such as quercetin and rutin which play a role as antioxidant against oxidative material which caused damage to liver. These results are in accordance with those Zeedan et al (2017) stated that plasma total protein, and globulin concentrations in treated rabbits with bee pollen increased significantly ( $P < 0.05$ ) than that of the control and urea ,creatinine ,cholesterol, total glycerides, AST and ALT were significantly ( $P < 0.05$ ) lower in the treated rabbits with bee pollen than control groups. Also, similar results obtained by Farag and EL-Rayes (2016) and Demir and Kaya (2020).

Economic calculations revealed that there was no significant difference among groups in regard to feed cost and total costs ( $P > 0.05$ , Table 6). The highest values of total and net revenue and the best economical efficacy were observed in HSD-BP500 group compared to HSD and HSD-BP250 groups.

,similar results obtained by Attia, et al. (2014), El-Neney and El-Kholy (2014) and Zeedan and El- Neney (2014) showed that rabbits treated with high level of BP recorded high value of EE and REE compared to control group.

#### 4. Conclusion;

The results of this study showed that the bee pollen can be used as a beneficial feed additive, could alleviate the detrimental effects of overcrowding on the productive and economic efficiency in growing rabbits. From the obtained results could be noted that the best level of bee pollen in rabbit ration was 500 mg/kg BW. However, further studies are needed with more numbers of animals and with more different doses.

#### Conflict of interest statement

No conflicts of interest.

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#### 5. References

- Abdel-Hamid, T.M., El-Tarabany, M.S., 2019. Effect of bee pollen on growth performance, carcass traits, blood parameters, and the levels of metabolic hormones in New Zealand White and Rex rabbits. 51, 2421-2429.
- Aboughaba, A.A. K., 2018. Impact of bee pollen supplementation on productive performance, some hematological parameters, blood constituents and semen physical characteristics of sinai chickens. Egyptian Poultry Science Journal. 38, 621-635.
- Attia, Y. A., El-Hanoun, A. M., Bovera, F., Monastra G., El-Tahawy, W. S., Habiba, H. I., 2014. Growth performance, carcass quality, biochemical and haematological traits and immune response of growing rabbits as affected by different growth promoters. J. Anim. Physiol. Anim. Nutr. 98, 128–139.
- Attia, Y.A., Al-Hanoun, A., El-Din, A.E., Bovera, F. Shewika, Y.E., 2011. Effect of bee pollen levels on productive, reproductive and blood traits of NZW rabbits. Journal of animal physiology and animal nutrition. 95, 294-303.
- Babaei, S., Rahimi, S., Karimi Torshizi, M.A., Tahmasebi, G. a Miran, S., 2016. Effects of propolis, royal jelly, honey and bee pollen on growth performance and immune system of Japanese quails. Veterinary research forum : an international quarterly journal. 7,13-20.
- Basavaraj, M., Nagabhushana, V., Prakash, N., Appannavar, M. M., Wagmare, P., Mallikarjunappa, S., 2011. Effect of dietary supplementation of curcuma longa on the biochemical profile and meat characteristics of broiler rabbits under summer stress. Veterinary World. 4, 15-18.
- Bovera, F., Nizza, S., Marono, S., Mallardo, K., Piccolo, G., Tudisco, R., De martino ,L., Nizza , A.,2010. Effect of mannan oligosaccharides on rabbit performance, digestibility and rectal bacterial anaerobic populations during an episode of epizootic rabbit enteropathy. World Rabbit Sci. 18, 9-16.
- Cocan, O., Marghitas, L.A., Dezmiorean, D., Laslo, L., 2005. Composition and biological activities of bee pollen: review. Bulletin of the University of Agricultural Science and Veterinary Med. 61, 221-226.
- Dacie, J.U., Lewis, S.M., (1991): Practical Haematology. Churchill Livingstone, UK.
- Demir, Z. ,Kaya, H., 2020. Effect of Bee Pollen Supplemented Diet on Performance, Egg Quality Traits and some Serum Parameters of Laying Hens. Pakistan Journal of Zoology. 52, 425-824.
- Dias, D.M.B., Oliveira, M.C.d., Silva, D.M.d., Bonifácio, N.P., Claro, D.d.C., Marchesin, W.A., 2013. Bee pollen supplementation in diets for rabbit does and growing rabbits. Acta Scientiarum. Animal Sciences. 35, 425-430.
- El-Hanoun, A. M., Hedia, H., El-Sbeyy, M. S., Kamel, K. I., 2007. Effect of bee pollen supplementation on some productive, reproductive and biochemical traits of growing male rabbits during winter and summer seasons. 5th Inte. Conf. on Rabbit Production in Hot Seasons, Hurghada, Egypt, 4–7 December. 417–433.
- El-Neney, Battaa. A. M., El-Kholy, K. H., 2014. Effect of natural additive (bee pollen) on immunity and productive and reproductive performances in rabbits.1-Growth performance, digestive and immune responses in growing rabbits. Egypt. Poult. Sci. 34, 579-606.
- Farag, S., El-Rayes, T., 2016. Effect of Bee-pollen Supplementation on Performance, Carcass Traits and Blood Parameters of Broiler Chickens. Asian Journal of Animal and Veterinary Advances. 11, 168-177.
- Habiba, H., Hassan, S., El-Naggar, A., 2015. Response of Growing Rabbits to Bio-additives. 1- Growth performance and carcass characteristics2nd Inter. Conf. on Modern Approaches in Livestock's Prod. Systems.
- Hamamoto, R., Ishiyama, K., Yamaguchi, M., 2006. Inhibitory Effects of Bee Pollen Cistus ladaniferus Extract on Bone Resorption in Femoral Tissues and Osteoclast-Like Cell Formation in Bone Marrow Cells in Vitro. Journal of Health Science. 52, 268-275.
- Haščík, P., Elimam, I., Garlík, J., 2012. the effect of addition bee pollen to feed mixtures on internal fat of broiler ross 308. Journal of Microbiology, Biotechnology and Food Sciences. 2, 246-252.

- Liu, G., Yan, W., Zeng, Z., 2010. Application of bee pollen in Gallus feed. *Journal of Bee*. 3, 22-29.
- Martin-Munoz, M.F., Bartolome, B., Caminoa, M., Bobolea, I., Ara, M.C., Quirce, S., 2010. Bee pollen: a dangerous food for allergic children. Identification of responsible allergens. *Allergologia et immunopathologia*. 38, 263-265.
- Nogueira, C., Iglesias, A., Feás, X., Estevinho, L.M., 2012. Commercial bee pollen with different geographical origins: a comprehensive approach. *Int J Mol Sci*. 13, 11173-11187.
- NRC. 1977. National research council. Nutrient requirements of rabbits. Washington, DC. U.S.A.
- Pascoal, A., Rodrigues, S., Teixeira, A., Feas, X., Estevinho, L.M., 2014. Biological activities of commercial bee pollens: antimicrobial, antimutagenic, antioxidant and anti-inflammatory. *Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association*. 63, 233-239.
- Xu, X., Sun, L., Dong, J., Zhang, H., 2009. Breaking the cells of rape bee pollen and consecutive extraction of functional oil with supercritical carbon dioxide. *Innovative Food Science & Emerging Technologies*. 10, 42-46.
- Yamaguchi, M., Hamamoto, R., Uchiyama, S., Ishiyama, K., Hashimoto, K., 2006. Anabolic Effects of Bee Pollen *Cistus ladaniferus* Extract on Bone Components in the Femoral- Diaphyseal and -Metaphyseal Tissues of Rats in Vitro and in Vivo. *Journal of Health Science*. 52, 43-49.
- Zeedan, Kh. I. I., Battaa, A. M. El-Neney., 2014. Effect of natural additives (bee pollen) on immunity and productive performances in rabbits. 3-Evaluation of high levels on growth performance, blood profile and carcass characteristics in rabbit males. 7th Int. Poult. Conf. 3 – 6 November, Ain Sukhna, Red Sea – Egypt.
- Zeedan, Kh.I.I., Elneney, Batta.A.M., Abuoghaba, A.A., EL-Kholy.K.H., ( 2017): Effect of bee pollen at different levels as natural additives on immunity and productive performance in rabbit males. *egypt. poult. sci*. 37, 213- 231.

**Table (2): Effect of bee pollen on growth performance of NZW rabbits reared under stocking density for seven successive weeks (mean  $\pm$  SE).**

Parameters	Experimental groups				SEM	P-value
	LSD	HSD	HSD-BP250	HSD-BP 500		
Initial BW, g/rabbit	566.37	564.65	566.98	567.88	1.16	0.351
Final BW, g/rabbit	2017.83 <sup>a</sup>	1567.58 <sup>d</sup>	1710.70 <sup>c</sup>	1910.40 <sup>b</sup>	17.83	0.0001
BWG, g/rabbit	1446.62 <sup>a</sup>	1006.91 <sup>d</sup>	1155.22 <sup>c</sup>	1330.14 <sup>b</sup>	18.72	0.0001
TFI, g/rabbit	5107.41 <sup>a</sup>	4807.47 <sup>b</sup>	4674.31 <sup>c</sup>	4535.31 <sup>d</sup>	18.88	0.0001
FCR (feed: gain)	3.53 <sup>c</sup>	4.77 <sup>a</sup>	4.05 <sup>b</sup>	3.40 <sup>c</sup>	0.06	0.0001
FE(gain: feed)	0.28 <sup>a</sup>	0.21 <sup>c</sup>	0.24 <sup>b</sup>	0.29 <sup>a</sup>	0.005	0.0001
Mortality rate %	1.00 <sup>d</sup>	13.00 <sup>a</sup>	10.00 <sup>b</sup>	7.00 <sup>c</sup>	0.45	0.0001

Means bearing different superscripts within the same row were significantly different ( $P < 0.05$ ). SEM = standard error of the mean.

**Table (3): Effect of bee pollen on carcass traits of NZW rabbits reared under stocking density at 11 weeks of age (mean  $\pm$  SE).**

Parameters	Experimental groups				SEM	P-value
	LSD	HSD	HSD-BP250	HSD-BP 500		
Slaughter weight (SW), g	2085.71 <sup>a</sup>	1609.07 <sup>d</sup>	1890.59 <sup>c</sup>	1960.12 <sup>b</sup>	18.60	0.0001
Skin, % SW	16.75	16.89	16.92	16.83	0.38	0.839
Full stomach, % SW	4.87 <sup>b</sup>	5.67 <sup>a</sup>	5.08 <sup>ab</sup>	5.25 <sup>ab</sup>	0.14	0.020
Full intestine, % SW	11.54	11.93	11.90	11.73	0.46	0.768
Chilled carcass weight (CCW), g	1202.87 <sup>a</sup>	843.56 <sup>d</sup>	989.59 <sup>c</sup>	1115.12 <sup>b</sup>	13.94	0.0001
Dressing out, %	57.67 <sup>a</sup>	52.42 <sup>b</sup>	52.22 <sup>ab</sup>	56.89 <sup>a</sup>	0.55	0.004

Head, % CCW	9.52	9.13	9.59	9.44	0.29	0.264
Liver, %CCW	6.08 <sup>a</sup>	5.12 <sup>b</sup>	5.56 <sup>ab</sup>	6.27 <sup>a</sup>	0.23	0.019
Kidney, % CCW	0.99 <sup>a</sup>	0.81 <sup>d</sup>	0.91 <sup>c</sup>	0.94 <sup>b</sup>	0.01	0.0001
Reference carcass weight (RCW), g	997.67 <sup>a</sup>	639.56 <sup>d</sup>	775.59 <sup>c</sup>	814.85 <sup>b</sup>	11.93	0.0001
Perirenal fat, % RCW	1.45 <sup>a</sup>	1.12 <sup>b</sup>	1.01 <sup>c</sup>	0.93 <sup>d</sup>	0.02	0.0001
Fore part, % RCW	38.23	37.50	37.99	38.01	0.39	0.322
Mid part, % RCW	20.87	19.64	19.90	19.99	0.33	0.154
Hind part, % RCW	39.29	34.42	39.10	39.25	0.52	0.069

Means bearing different superscripts within the same row are Significantly different Table (4): Effect of bee pollen on blood hematology of NZW rabbits reared under stocking density at 11 weeks of age (mean  $\pm$  SE).

Parameters	Experimental groups				SEM	P-value
	LSD	HSD	HSD-BP250	HSD-BP 500		
RBCs, 10 <sup>6</sup> / $\mu$ l	5.87 <sup>a</sup>	4.50 <sup>b</sup>	4.67 <sup>b</sup>	4.89 <sup>b</sup>	0.96	0.001
Hb, g/dl	14.36 <sup>a</sup>	10.28 <sup>b</sup>	10.67 <sup>b</sup>	11.34 <sup>b</sup>	0.33	0.005
PCV, %	34.97 <sup>a</sup>	31.99 <sup>b</sup>	33.24 <sup>ab</sup>	34.84 <sup>a</sup>	0.37	0.012
MCV, fl	64.35	62.90	63.70	63.95	0.54	0.895
MCH, pg	23.91	23.35	23.95	23.88	0.44	0.260
WBCs, 10 <sup>3</sup> / $\mu$ l	7.50 <sup>c</sup>	8.74 <sup>b</sup>	10.12 <sup>a</sup>	10.45 <sup>a</sup>	0.19	0.0001
Lymphocytes, %	66.96 <sup>c</sup>	69.66 <sup>ab</sup>	72.96 <sup>b</sup>	77.49 <sup>a</sup>	1.32	0.0001
Heterophils, %	36.50 <sup>c</sup>	37.35 <sup>ab</sup>	38.84 <sup>ab</sup>	40.40 <sup>a</sup>	0.37	0.002
H : L ratio	0.55 <sup>a</sup>	0.54 <sup>a</sup>	0.53 <sup>ab</sup>	0.52 <sup>b</sup>	0.004	0.017

Table (5): Effect of bee pollen on serum biochemical parameters of NZW rabbits reared under stocking density at 11 weeks of age (mean  $\pm$  SE).

Parameters	Experimental groups				SEM	P-value
	LSD	HSD	HSD-BP250	HSD-BP 500		
Total protein, g/dl	5.91 <sup>a</sup>	4.43 <sup>b</sup>	5.40 <sup>a</sup>	6.22 <sup>a</sup>	0.18	0.0001
Albumin, g/dl	3.70	3.27	3.60	3.60	0.09	0.700
Globulin, g/dl	2.21 <sup>a</sup>	1.16 <sup>b</sup>	2.5 <sup>a</sup>	2.62 <sup>a</sup>	0.09	0.0001
Total cholesterol, mg/dl	78.41 <sup>a</sup>	77.05 <sup>b</sup>	72.10 <sup>b</sup>	71.95 <sup>b</sup>	0.61	0.001
Triglycerides, mg/dl	126.03 <sup>a</sup>	121.70 <sup>ab</sup>	118.90 <sup>b</sup>	110.23 <sup>c</sup>	0.71	0.0001
Urea, mg/dl	31.86 <sup>a</sup>	26.36 <sup>b</sup>	25.20 <sup>ab</sup>	24.03 <sup>c</sup>	0.33	0.0001
Creatinine, mg/dl	1.36 <sup>a</sup>	0.97 <sup>b</sup>	0.80 <sup>c</sup>	0.71 <sup>d</sup>	0.02	0.0001
AST, U/l	25.50 <sup>a</sup>	24.67 <sup>a</sup>	22.12 <sup>b</sup>	22.01 <sup>b</sup>	0.45	0.0001
ALT, U/l	81.50 <sup>b</sup>	81.98 <sup>a</sup>	77.03 <sup>b</sup>	65.85 <sup>c</sup>	0.85	0.0001

Means bearing different superscripts within the same row are significantly different.

AST= aspartate aminotransferase; ALT= alanine aminotransferase

SEM = standard error of the mean

Table (6): Effect of bee pollen on economic measurements of NZW rabbits reared under stocking density at 11 weeks of age (mean  $\pm$  SE).

Parameters	Experimental groups				SEM	P-value
	LSD	HSD	HSD-BP250	HSD-BP 500		
Feed cost, LE/rabbit	25.54	24.04	23.37	22.68	0.48	0.189
Total cost ,LE/rabbit	55.54	54.04	56.04	57.03	0.66	0.141
Total revenue, LE/rabbit	90.81 <sup>a</sup>	70.54 <sup>b</sup>	76.98 <sup>c</sup>	85.03 <sup>d</sup>	1.01	0.0001
Net revenue, LE/rabbit	35.27 <sup>a</sup>	16.50 <sup>b</sup>	20.94 <sup>c</sup>	27.09 <sup>d</sup>	0.84	0.0001
Cost-benefit ratio	0.61 <sup>c</sup>	0.77 <sup>a</sup>	0.72 <sup>b</sup>	0.67 <sup>b</sup>	0.01	0.0001
Economic efficiency	1.6 <sup>a</sup>	1.30 <sup>c</sup>	1.47 <sup>b</sup>	1.49 <sup>b</sup>	0.02	0.0001

Means bearing different superscripts within the same row were significantly different ( $P < 0.05$ ).

Price of kg diet = 5 L.E; price of kg live body weight = 45 L.E; Fixed cost = 2 L.E. per rabbit.

Cost of bee pollen was 0.10 L.E for HSD-BP250 and 0.20 L.E for HSD-BP500 per rabbit .

LSD= low stocking density group (6 rabbits/m<sup>2</sup>); HSD= high stocking density group (24 rabbits/m<sup>2</sup>); HSD-BP250 = high stocking density and rabbits fed diet supplemented with bee pollen at 250 mg/kg BW; HSD-BP500= high stocking density and rabbits fed diet supplemented with bee pollen at 250 mg/kg BW.

SEM = standard error of the mean.