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PRODUCTIVE PERFORMANCE, BLOOD CONSTITUENTS AND SOME PHYSIOLOGICAL PARAMETERS OF RABBIT BUCKS ADMINISTERED WITH BEE POLLEN UNDER HOT CONDITIONS PREVALENT IN ASSIUT

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The impact of treatment with bee pollen (BP) on the productive performance and some hematological and physiological traits of rabbit bucks were studied under hot climatic conditions prevalent in Assiut during the summer season. A number of 30 rabbit bucks (15 V-line & 15 Moshtohor line); 14 weeks old were divided into three equal experimental groups. The bucks of 1st group were fed on a commercial basal ration and served as control, while those in the 2nd and 3rd groups were fed on the same ration in addition to daily oral supplementation with 250 and 500mg BP/buck, respectively in gelatin capsulated form allover experimental period.

The obtained results revealed significant rabbit line differences in total feed intake (TFI/g), RBCs (10^6), total protein (TP), glucose (mg/dl), total lipids (g/L), aminotransferase(ALT/IU/L), IgG (mg/dl), IgM (mg/dl) and Tri-iodothyronine (T3/ng/dl) hormone concentration. While, the differences were insignificant in the productive traits, Hb (g/dl), HTC (%), cholesterol (g/dl), total antioxidant capacity (TAC/mm/l), aspartate aminotransferase (AST), follicle-stimulating hormone (FSH), testosterone (Testos) and Luteinizing hormone (LH) hormone concentrations. The total feed intake of bucks treated with 250 and 500mg BP/buck decreased by 4.45 and 8.48%, but the means of BW (g), BWG (g) and PI (%) increased significantly (P<0.01 or 0.05) than those of the control. The means of Hb (g/dl), HTC (%), RBCs (10^6) and Lymphocytes (%) of the bucks treated with BP increased significantly (P<0.01 or 0.05) than those of the control. The means of TP, albumin, globulin (g/dl) and glucose (mg/dl) levels as well as TAC (%), IgG (mg/dl), IgM (mg/dl) of the treated bucks significantly (P<0.01 or 0.05) increased, whereas the levels of

cholesterol (mg/dl), total lipids (TL/g/l), AST (IU/l) and ALT (IU/l) were significantly (P<0.01 or 0.05) decreased. In the treated bucks, the concentrations of testosterone, FSH, and LH hormones improved significantly (P<0.01) than those of the control group.

***Conclusively,** it could be concluded that treating rabbits raised under hot climatic conditions with 250 and 500 BP/ buck improved significantly the feed intake, hematological variables, immunological responses and hormonal estimates.*

Keywords: Bee Pollen, Rabbit bucks, Performance, Immunological parameters, Physiological measurements.

The use of antibiotics in animal and poultry production was banned by the European community in 2006. Therefore, several studies were performed to find out other alternative biological products to improve the efficiency of feed utilization of rabbits, which consequently results in higher growth rate, better immunity and more efficient financial profitability (Perić *et al*., 2009 and Dias *et al.*, 2013). Bee pollen is an agglomerate of flower pollen grains, gathered by honey bees and mixed with plant nectar and bee saliva enzymes, which improves its therapeutical efficiency (Carpes *et al*., 2008 and Leblanc *et al*., 2009). Bee pollen is a rich source of protein (25-30%), polyunsaturated fatty acids (51%) as well as linolenic acid 39%, palmitic acid 20%, and linoleic acid 13% and more than 12 vitamins, 28 minerals as Zn, Cu, Fe, Se and high K/Na ratio, 59 trace elements, 11 enzymes or coenzymes, 35-65% carbohydrates, which include glucose, fructose and sucrose in addition to flavonoids, carotenoids and phytosterols (Xu *et al.*, 2009; Attia et al., 2011a, b and Haščík, *et al*., 2012).

The chemical analysis of bee pollen, as found by many researchers is rich in provitamins and vitamins: thiamine, riboflavin, pyridoxine, nicotinic acid, pantothenic acid, folic acid, beta-carotene, vitamin C, tocopherol and ergocalciferol (Villanueva, 2002 and Bastos, 2004), and in minerals as phosphorus, potassium, iron, magnesium, copper, zinc and manganese (Human and Nicolson, 2003). Similarly, Carpes *et al*., (2007) and Campos *et al.*, (2010) stated that the bee pollen is rich in polyphenolic substances, flavonoids, phytosterols and other health-promoting substances, which indicate the presence of free radical scavenging and antioxidants activity. Also, the findings of some researchers revealed that bee pollen tended to have some therapeutical characteristics as antibacterial (Proestos *et al*. 2005), antifungal (García *et al*., 2001), antibiotic, antidiarrhoeic and antioxidant (Almaraz-Abarca *et al.* 2004 and Hajkova *et al.* 2013). Besides,

Song *et al*. (2005) stated that BP could improve the cell immune response through enhancing the speed of antibody production and reinforcing the immunological system.

Also, the findings of Attia *et al.* (2011a and 2014) indicated that the BWG of newly weaned kids treated with BP increased significantly and coincided with improve feed conversion ratio up to 12 weeks of age, while the feed consumption and the mortality rate were relatively decreased. Similarly, the results of El-Hanoun *et al.* (2007) indicated that treating the growing rabbits with 250 and 500 mg bee pollen/kg BW increased significantly their growth and survival rate from weaning up to mature age. Also, Hedia *et al*. (2007) reported that treating rabbits with BP increased the plasma glucose, total protein, and albumin concentrations.

Therefore, the current study aimed to evaluate the impact of supplementing rabbit bucks with BP on the productive performance, liver enzymes and some physiological and immunological traits.

MATERIALS AND METHODS

The present study was performed at the Experimental Rabbitry Farm of Poultry Production Department, Faculty of Agriculture, Assiut University during the period from June up to September, 2015. It worth to mention that the local Egyptian Moshtohor line was developed by crossing Spanish V-line rabbit does with Sinai Gabali bucks (Iraqi *et al.,* 2008). The Spanish V-line is a synthetic maternal line, which originated at the Department of Animal Science, Universitat Politecnica de Valencia, Spain in 1983 by crossing the progeny of four specialized maternal lines without selection for three generations and has been selected for weaned litter size (Estany *et al.*, 1989).

Experimental animals and management

Thirty healthy rabbit bucks including 15 of both V-line and Moshtohor line; 14 weeks old were divided into three equal groups. Bucks in the 1st group (control) were fed on a the commercial basal ration, while those in the 2nd and 3rd groups were fed the same ration but administered orally daily with 250 and 500mg BP/buck in capsulated form and considered as treated groups. All bucks were individually placed in wire galvanized battery cages (50L×50W× 40H) under the same adequate environmental conditions, and exposed to 16 lighting hours/ daily. The fed and fresh tap water was provided *ad-libitum*.

The commercial basal ration included 17.0% crude protein, 2.99% fat, 12.5% crude fiber, 0.6% minerals mixture and 2500 K cal/kg digestible energy, which covered the needed requirements according to A.O.A.C., (2000).

Environmental conditions

Ambient temperature (^{o}C) and relative humidity (%) were recorded inside the rabbitry allover the day by using a thermo-hygrograph. The averages of minimal and maximal ambient temperature as well as the relative humidity were measured as shown in Table 1.

The maximal temperature was determined as the average of five measurements at 10AM, 12Noon, 2, 4 and 6 PM, while the minimal temperature was determined at 8 and 10 PM, 12 Mid night, 2 and 4AM, respectively. The temperature humidity indices (THI) were calculated according to the equation of Marai *et al*., 2001:

$$THI=db^{o}C-[(0.31-0.31\times RH) \times (db^{o}C-14.4)],$$

Where $db^{o}C$ = Dry bulb temperature and RH%= Relative humidity. The values of THI were classified into four categories: <27.8 (absence of heat stress), 27.8-28.8 (Moderate heat stress), 28.9-29.9 (Severe heat stress) and >30.0 (Very severe heat stress).

Table 1. Ambient temparature (ATlºC), Relative humidity (RH/%) and THI (units) allover the experimental period

Months	Minimum			Maximum			Mean		
	AT (ºC)	RH (%)	THI (Units)	AT (ºC)	RH (%)	THI (Units)	AT (ºC)	RH (%)	THI (Units)
June	26.4	58	24.84	38	48	34.19	32.2	53	29.60
July	28.4	55	26.45	41	52	37.04	34.7	53.5	31.77
Aug	28.2	52	26.12	42	48	37.55	35.1	50	31.89
Sep	26.6	58	25.01	40	52	36.19	33.3	55	30.66

AT (ºC) = Ambient temperature, RH (%) = Relative humidity, THI (units) = Temperature humidity index

Traits under study:

***Productive performance*:** The initial and final body weights for each buck were recorded at 9.0 AM o'clock in the 14th and 24th weeks of the experimental period. The total BWG was calculated during the period between 14 and 24 weeks of age by subtracting the initial body weight from the final corresponding ones**.** The total feed consumption (g) was recorded during the same period. The feed conversion ratio (FCR) was calculated as g feed/g weight gain. The performance index (PI) was calculated as (Final body weight (kg) / Feed conversion) ×100} according to North (1981).

Blood parameters: At 22nd weeks of age (after 8 weeks from the beginning of experiment), 30 blood samples, 10 samples in each group (3 ml each) were collected at 10.0 AM from the marginal ear vein in both heparinized and nonheparinized tubes to measure biochemical analysis.

Hematological parameters: All blood samples were run in duplicate and assayed by the same investigator, who was blind to the experimental situation. Non-coagulated blood was tested shortly after collection for the count of red blood cells (RBCs, 10^6), white blood cells (WBCs, 10^3), Differential count of WBC's subclasses (lymphocyte, neutrophils, monocytes, eosinophils, and basophils percentages), hemoglobin (Hb, g/dl) concentration and hematocrit value (HTC, %) according to Drew *et al.* (2004).

Therefore, blood samples were separated by centrifugation at 3000 rpm for 15 minutes and kept in a deep freezer at (-20°C) until analysis.

Blood constituents: The serum total protein (TP) was measured by using commercial kits according to the method of Armstrong and Corri (1960), while serum albumin (Alb) was determined by using special kits according to Doumas *et al.* (1971). Globulin values were obtained by subtracting albumin concentrations from the corresponding values of the total protein. Total lipids and cholesterol levels in the serum were measured by using specialized commercial kits (Diamond Diagnostic, Egypt). Plasma total antioxidant capacity (mmol/L) was measured according to Erel (2004).

Liver enzymes: The plasma Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) were assayed according to Reitman and Frankel (1957).

Hormonal estimates: The concentrations of serum follicle stimulating hormone (FSH/ ng/ml), and Luteinizing hormone (LH/ MIU/ml) hormone were determined by ELISA technique, while plasma testosterone (ng/ml) and tri-iodothyronine (T3) hormones were measured by DRG International, Inc., USA Kits According to the method of Tietz, (1995).

Statistical analysis: Data were analyzed by the least square analysis of variance using GLM procedure of the statistical analysis model (SAS, 2004) as follow:

$$Yij = \mu + B_i + T_j + B_iT_j + e_{ij}$$

Where: Y_{ij}= The individual observation, μ= Overall mean, B_i= Rabbit line (i = 1, 2), Tj= Effect of BP treatment (j = 1, 2 and 3), BT_{ij}= Fixed interacting effect between rabbit line and BP treatment; Eij= Random error component was normally distributed assumed.

The significant differences between treatment means were determined by using Duncan's new multiple ranges tests (Duncan, 1955).

RESULTS AND DISCUSSIONS

Data presented in Table 2, showed significant ($P<0.004$) differences in total feed intake between V-line and Moshtohor lines, while those of BW, BWG, FCR and PI were insignificantly affected. The improved feed intake for V-line bucks may be due to genetical differences. These results disagree with those of El-Bayomi *et al*., (2012), who found that the progeny of different genotypes varied significantly in weights at weaning and post-weaning.

Regarding the treatment of BP, the achieved results revealed that the FBW (g), BWG (g) and PI (%) for bucks in the treated groups were significantly ($P<0.01$) increased than those of the control. In contrast, TFI (g) and FCR for the treated bucks were significantly ($P<0.001$) improved by about (4.4 & 8.5%) and (18.2 & 22.4%) than those of control. The increased FBW, BWG and PI in the treated groups could be attributed to improved digestibility of the crude protein, which in turn improved the nutrient and protein utilization resulting in higher protein anabolism and intestinal absorptive capacity.

The decreased total feed intake of the treated bucks may be due to the role of BP in improving the protein utilization by the flavonoids, which consequently enhanced the digestion, absorption, and utilization of nutrients. The obtained results are in agreement with those of El-Hanoun *et al.* (2007), who stated that the orally administered NZW rabbit does with 100, 200, and 300mg propolis/kg, BW and feed conversion ratio were significantly improved, while the averages of daily feed consumption were significantly inferior to those in control group. Also, the achieved findings agree with those of Attia *et al.* (2011a), who found that the feed intake of kids produced by rabbit does supplemented with bee pollen decreased remarkably than those of the control group from 4 to 12 weeks of age. Similarly, Abou El-Naga (2014) found that the feed intake of Norfa chicken administrated with 1 or 2% BP decreased significantly ($P\leq0.05$), which improved the FCR than those of the control. The interactions between lines and BP treatments were insignificant in all productive studied traits except the total feed intake. There were no mortality cases during the experimental period, which lasted 10 weeks.

Hematological variables

The obtained results in Table 3 indicate significant ($P\leq0.01$ or 0.05) line differences in RBCs (10^6), Lymphocytes and Neutrophils. In contrast, the means of Hb, HTC, WBCS (10^3), monocytes, eosinophils and basophils

Table 2. Productive performance of rabbit bucks affected by lines, BP treatment and their interaction

Traits→ / Rabbit line ↓ / Treatment ↓		Body weight (g)		Weight gain (g)		TFI (g)	FCR (g feed /g gain)	PI (%)
		Initial (14W)	Final (24W)	Total	Daily			
Effect of rabbit line (B)								
V-Line		2138.66	2895.00	756.33	10.80	6118.77[a]	8.26	36.25
Moshtohor		2214.67	2961.66	747.00	10.67	5783.02[b]	7.94	38.36
SEM		35.74	25.48	26.24	0.37	54.70	0.29	1.44
Effect of BP treatment (T)								
Control (C)		2173.50	2843.50[b]	670.00[b]	9.57[b]	6220.17[a]	9.37[a]	30.74[b]
250mg (T1)		2175.00	2969.00[a]	794.00[a]	11.34[a]	5941.20[b]	7.66[b]	39.77[a]
500mg (T2)		2181.50	2972.50[a]	791.00[a]	11.30[a]	5691.33[c]	7.27[b]	41.40[a]
SEM		43.78	31.21	32.14	0.46	67.00	0.36	1.76
Effect of interaction (B×T)								
V-Line	Control	2128.0	2806.0	678.00	9.68	6583.00	9.74	28.94
	250mg	2138.0	2934.0	796.00	11.37	6020.00	7.73	38.98
	500mg	2150.0	2945.0	795.00	11.36	5753.33	7.32	40.83
Moshtohor	Control	2219.0	2881.0	662.00	9.46	5857.33	8.99	32.54
	250mg	2212.0	3004.0	792.00	11.31	5862.40	7.59	40.56
	500mg	2213.0	3000.0	787.00	11.24	5629.33	7.21	41.97
SEM		61.9	44.14	45.4	0.65	94.7	0.5	2.49
Probability								
Rabbit line (B)		0.1458	0.0767	0.8036	0.8036	0.0002	0.4365	0.3101
Treatment (T)		0.9906	0.0105	0.0171	0.0171	0.0001	0.0008	0.0005
Interaction (B*T)		0.9744	0.9726	0.9910	0.9910	0.0061	0.7829	0.8704

[A, b, c] Means with different superscripts in the same column for every factor are significantly different ($P< 0.05$).

TFI= Total feed intake, FCR= Feed conversion ratio, PI= Performance index (Final body weight (kg) / Feed conversion) ×100.

were insignificantly affected. The Moshtohor rabbit bucks showed significant higher RBCs (10^6) and Neutrophils (%) than their corresponding in V-line rabbit bucks. This might be attributed to the improved hepatic functions of Moshtohor than those of V-line bucks. These results agree with those of Khalil *et al*., (2015), who found that the means of RBCs, Neutrophils, lymphocytes for Baladi bucks increased significantly ($P<0.01$), while the means of Hb, PCV and Monocytes were insignificantly affected as compared with the corresponding values of NZW rabbit bucks.

Referring to the treatment with BP, the achieved findings indicated that the means of Hb (g/dl), HTC (%), RBCs (10^6), Lymphocytes and

Table 3. Hematological variables of rabbit bucks affected by rabbit lines, BP treatment and their interaction

Traits→ Rabbit line ↓ Treatment ↓		Hg (g/dl)	HTC (%)	RBCs (10^6)	WBCS (10^3)	WBCS deferential				
						L (%)	M (%)	N (%)	E (%)	B (%)
Effect of rabbit line (B)										
V-Line		11.26	31.16	5.32^{b}	6.46	64.13^{a}	1.74	30.99^{b}	1.64	1.51
Moshtohor		11.97	32.12	5.71^{a}	6.68	62.91^{b}	1.66	32.47^{a}	1.58	1.37
SEM		0.36	0.41	0.07	0.18	0.25	0.08	0.22	0.08	0.05
Effect of BP treatment (T)										
Control (C)		10.48^{b}	29.24^{c}	5.24^{b}	6.29	60.42^{c}	1.92^{a}	34.33^{a}	1.73	1.60^{a}
250mg (T1)		11.90^{a}	31.48^{b}	5.53^{a}	6.61	64.03^{b}	1.73^{ab}	31.19^{b}	1.64	1.41^{b}
500mg (T2)		12.46^{a}	34.18^{a}	5.77^{a}	6.81	66.11^{a}	1.46^{b}	29.67^{c}	1.46	1.30^{b}
SEM		0.44	0.50	0.08	0.22	0.30	0.10	0.27	0.096	0.06
Interaction (B×T)										
V-Line	Control	10.90	30.13	5.36	6.46	60.52	1.96	34.08	1.80	1.64
	250mg	12.04	32.16	5.68	6.38	64.92	1.74	30.24	1.64	1.46
	500mg	12.98	34.06	6.08	6.54	66.94	1.52	28.64	1.48	1.42
Moshto-hor	Control	10.06	28.36	5.12	6.12	60.32	1.88	34.58	1.66	1.56
	250mg	11.76	30.82	5.38	6.84	63.13	1.72	32.14	1.64	1.37
	500mg	11.94	34.30	5.46	7.08	65.27	1.39	30.70	1.44	1.19
SEM		0.62	0.70	0.12	0.31	0.42	0.14	0.38	0.14	0.09
Probability										
Rabbit line (B)		0.1730	0.1095	0.0005	0.3903	0.0018	0.5091	0.0001	0.5880	0.0793
Treatment (T)		0.0124	0.0001	0.0007	0.2530	0.0001	0.0123	0.0001	0.1581	0.0092
Interaction (B×T)		0.8178	0.3410	0.2454	0.2976	0.1344	0.9381	0.1046	0.8635	0.6393

[A, b, c] Means with different superscripts in the same column for every factor are significantly different ($P< 0.05$).

Hg = Hemoglobin, HTC= Hematocrit, RBCs= Red blood cells, WBCs= White blood cells, L= Lymphocytes, M= Monocytes, N= Neutrophils, E= Eosinophials and B= Basophile.

Neutrophils (%) in the treated bucks increased significantly ($P\leq0.01$ or 0.05), while the means of Monocytes and Basophils were significantly ($P\leq0.01$) decreased than the corresponding levels of the control.

The increased Hb (g/dl), HTC (%) and RBCs (10^6) as well as Lymphocytes and Neutrophils percentages for treated bucks may be due to the stimulating role of bee pollen in enhancing the immune functions through increasing Hb (g/dl), HTC (%) and RBCs (10^6). This means that the addition of bee pollen increased RBC's, which consequently rose both of the hematocrit and hemoglobin levels.

In mammals, the lymphocyte is considered as a good indicator for increasing the immune responses in addition to a considerable increase in the main type of WBC's counts. Song *et al.*, (2005) found that supplementing the

rations of rabbits with BP could improve the cellular immune responses through enhancing the speed of antibody production and immunological system. The achieved findings agree with those of Ondruska *et al.*, (2011), who stated that exposing NZW rabbits to heat stress decreased the level of ACTH, which resulted in decreasing the Hb concentration and RBC counts. Similar results were also obtained by El-Neney and El-Kholy (2014), who stated that the RBC's, and WBC's counts in rabbits treated with BP were significantly ($P \leq 0.05$) increased than those of the control. These findings showed that the interactions among rabbit line and treatments had no significant effects on the hematological traits.

Blood constituents

Data in Table 4 revealed that the differences in the concentrations of total protein for both rabbit lines were significantly affected, while the levels of albumin and globulin were not affected. The average of total protein (mg/dl) in Moshtohor bucks exceeded significantly than that of the V-line bucks. This improvement may be attributed to the more enlarged, vital and active liver of Moshtohor bucks than those of V-line. The achieved findings agree with those of Abdel-Hamid and Farahat (2015), who reported that the means of blood protein concentrations varied significant ($P<0.01$) between the different breeds.

The achieved means of glucose (g/dl) and total lipids (g/L) in Moshtohor rabbit bucks increased significantly ($P<0.05$) than those of the V-Line bucks. These differences may be attributed to the genetically variations, which are of great diagnostic significance through the contribution in protein and the involvement of the enzymes, hormones and antibodies as well as in keeping the osmotic pressure, maintaining the acid-base balance, in addition being a nutritional reserve source for the body's tissues and muscles. The decreased glucose level in V-line kids may be due to the increased utilization of glucose resulting in increasing secretions of anabolic and catabolic enzymes, which consequently improve the metabolic rate.

Regarding the effects of BP, the achieved results indicated that the bucks treated with BP had the highest total protein ($P<0.001$), albumin ($P<0.01$) and globulin ($P<0.001$) than those of the control. The increased total proteins in the treated groups may be due to the improved digestibility of crude protein, which increases the amino acids supplementation. These results are in agreement with those of El- nagar *et al.,* (2010), who found that the serum total protein in growing rabbits, which have been orally given once a week at 200, 400 or 800 mg royal jelly (RJ)/kg BW significantly increased than those of the control. Similar results were also reported by Attia *et al.,* (2014), who found that the means of albumin and globulin levels for growing rabbit were insignificantly affected by BP supplementation in the diet.

The obtained findings showed that the treated bucks with BP significantly ($P<0.0001$) increased the glucose (g/dl) level, while the means of the cholesterol (mg/dl) and total lipids (g/L) were significantly decreased ($P<0.0001$) than those of the control. The increased glucose levels for the treated bucks with BP could be attributed to increased sugar availability, especially for both biochemical and physiological body functions. The decreased cholesterol and total lipids for bucks treated with BP could be attributed to the impact of BP on lipid metabolism, in addition to the positive effects of the unsaturated fatty acids, which prevent the accumulation of lipid peroxidation products. The achieved findings agree with those of El-Neney and El-Kholy (2014), who stated that the glucose level increased significantly, while the means of cholesterol and total lipids for the male growing NZW rabbits, which were daily supplemented with 200, 300 and 400mg BP/kg BW, decreased significantly ($P<0.05$) than those of the control. The achieved results agree with those of Xu *et al*., (2009), who attributed the decreased levels of cholesterol and lipids to the impact of phospholipids and linolenic fatty acid in BP, which represented about 1.19%.

The increased total antioxidant capacity (TAC/mm/l) in the treated bucks may be attributed to the increase of absorbed vitamins, amino acids and trace elements from bee pollen, which consequently improved the proliferation, development, and differentiation of the intestinal cells resulting in improving the conditions of intestinal microbial activity. These results agree with the findings of Attia *et al.,* (2014), which showed a significant

Table 4. Blood constiuintes (within normal range) of rabbit bucks affected by rabbit line, BP treatment and their interaction

Traits→ Rabbit line ↓ Treatment ↓		Blood proteins			Glucose (mg/dl)	Cholesterol (mg/dl)	Total Lipids (g/L)	TAC (mm/l)
		TP (g/dl)	Alb (g/dl)	Glob (g/dl)				
Effect of rabbit line (B)								
V-Line		7.75[b]	4.25	3.50	112.24[b]	74.53	3.99[b]	0.79
Moshtohor		7.96[a]	4.31	3.66	120.21[a]	77.81	4.69[a]	0.82
SEM		0.073	0.05	0.06	1.10	1.95	0.11	0.02
Effect of BP treatment (T)								
Control (C)		7.24[c]	4.19[b]	3.05[c]	100.30[c]	90.25[a]	4.87[a]	0.58[b]
250mg (T1)		7.94[b]	4.26[ab]	3.68[b]	120.08[b]	71.20[b]	4.21[b]	0.89[a]
500mg (T2)		8.40[a]	4.39[a]	4.01[a]	128.31[a]	67.06[b]	3.93[b]	0.95[a]
SEM		0.09	0.06	0.07	1.34	2.39	0.13	0.03
Interaction (B×T)								
V-Line	Control	7.11	4.16	2.95	98.30	86.00	4.61	0.56
	250mg	7.84	4.22	3.62	114.04	70.00	3.82	0.88
	500mg	8.30	4.36	3.94	124.40	67.60	3.55	0.93
Mosht-ohor	Control	7.37	4.22	3.15	102.30	94.50	5.16	0.60
	250mg	8.04	4.30	3.73	126.12	72.40	4.60	0.91
	500mg	8.50	4.42	4.08	132.22	66.52	4.32	0.96
SEM		0.13	0.09	0.11	1.90	3.38	0.19	0.04
Probability								
Rabbit line (B)		0.0466	0.3805	0.0934	0.0001	0.2474	0.0002	0.3148
Treatment (T)		0.0001	0.0951	0.0001	0.0001	0.0001	0.0001	0.0001
Interaction (B×T)		0.9664	0.9864	0.9272	0.1272	0.3729	0.7897	0.9764

[A, b, c] Means with different superscripts in the same column for every factor are significantly different ($P < 0.05$). TP= Total protein, Alb= Albumin, Glob= globulin, TAC= Total antioxidant capacity.

increase in the total antioxidants capacity for rabbits supplemented with BP in the diet as compared to the control group. There were no significant differences in the concentrations of blood proteins, glucose, cholesterol, total lipids and TAC (mm/l) due to the interaction between rabbit line and BP treatment groups.

Liver enzymes and immune responses

From data presented in Table 5, it could be noted that the means of ALT (IU/L), IgG (mg/dl) and IgM (mg/dl) for Moshtohor bucks increased significantly ($P<0.001$) than those of V-line. The increased immune responses could be attributed to the higher metabolic rate and the improved the immune activity in Moshtohor bucks than those in V-line.

The treated bucks with BP had significantly ($P\leq0.05$) decreased AST and ALT than those of the control bucks. This could show that the supplementing the rabbit bucks with BP has no adverse effects on the liver

Table 5. Liver functions, immune responses and hormonal estimates of rabbit bucks affected by rabbit line, BP treatment and their interaction between them.

Traits→ / Rabbit line ↓ / Treatment ↓		Liver enzymes		Immune responses		Hormonal estimates			
		AST (IU/L)	ALT (IU/L)	IgG (mg/dl)	IgM (mg/dl)	Testos. (ng/ml)	FSH (ng/ml)	LH (MIU/ml)	T3 (ng/dl)
Effect of rabbit line (B)									
V-Line		28.66	25.71^{b}	58.65^{b}	68.84^{b}	3.96	10.34	5.79	1.57^{b}
Moshtohor		28.95	26.63^{a}	62.99^{a}	74.39^{a}	4.27	10.82	6.06	1.91^{a}
SEM		0.24	0.21	1.28	0.96	0.14	0.32	0.34	0.03
Effect of BP treatment (T)									
Control (C)		29.76^{a}	26.64^{a}	55.44^{b}	68.21^{b}	3.55^{b}	9.59^{b}	5.09^{b}	1.40^{b}
250mg (T1)		28.30^{b}	25.82^{b}	65.69^{a}	72.44^{a}	4.32^{a}	11.12^{a}	6.22^{ab}	1.88^{a}
500mg (T2)		28.35^{b}	26.05^{ab}	63.70^{a}	74.19^{a}	4.47^{a}	11.04^{a}	6.47^{a}	1.95^{a}
SEM		0.29	0.26	1.57	1.18	0.17	0.40	0.41	0.03
Interaction (B×T)									
V-Line	Control	29.44	26.22	52.76	65.68	3.32	9.42	5.00	1.22
	250mg	28.25	25.34	58.34	69.59	4.20	10.84	6.08	1.70
	500mg	28.30	25.57	64.85	71.24	4.36	10.76	6.30	1.80
Mosh-tohor	Control	30.09	27.07	58.12	70.73	3.78	9.76	5.18	1.58
	250mg	28.36	26.31	64.32	75.28	4.44	11.38	6.36	2.06
	500mg	28.40	26.53	66.54	77.15	4.58	11.32	6.64	2.09
SEM		0.41	0.37	2.22	1.67	0.24	0.56	0.59	0.05
Probability									
Rabbit line (B)		0.3996	0.0057	0.0245	0.0004	0.1243	0.3040	0.5801	0.0001
Treatment (T)		0.0020	0.0973	0.0005	0.0046	0.0016	0.0188	0.0617	0.0001
Interaction (B×T)		0.7433	0.9838	0.5860	0.9648	0.8596	0.9775	0.9901	0.7175

$^{A, b, c}$ Means with different superscripts in the same column for every factor are significantly different ($P< 0.05$).

AST = Aspartate amino transferase, ALT= Alanine amino transaminase, Testos = testosterone hormone, T3= Tri-iodothyronine,

tissues and their functions. These results are in agreement with those of Hedia *et al.,* (2007), who found that the means of AST and ALT concentrations in the serum of female rabbits treated with bee pollen decreased significantly than those of the control.

It worth to mention that the levels of IgG and IgM in the treated rabbit bucks with BP increased significantly (P=0.01 & 0.0373) than those of control. This improvement in immune responses could be attributed to the improved immune activity in the treated bucks than those of the control. These results agree with the findings of Yamada *et al.,* (1990), who found that

the substances known to have immunoglobulin (Ig) production stimulating factor activity as royal jelly, which increased the IgM concentration by about 2.25-fold in the tested lymph node lymphocytes from breast cancer patients.

Hormonal estimates

Data presented in Table 5, showed that the concentration of testosterone, FSH and LH hormones in Moshtohor bucks increased insignificantly than those of V-line bucks.

The treated bucks with BP increased significantly (P=0.0016) the concentrations of testosterone hormone by about 17.8 and 20.6% as compared with the control group. A similar trend was obtained for FSH and LH hormones concentrations (P= 0.0188 and 0.0617, respectively), as they increased by 13.7 and 13.1% as well as by 18.2 and 22.2% than those of the control. This improvement in testosterone, FSH and LH hormone concentrations of treated rabbit bucks may be attributed to the high contents of BP, mainly in phospholipids, vitamins, mineral and antioxidant factors (Saric´*et al.,* 2009), which have improving effects on the fertility and semen quality traits (Xu *et al.,* 2009 and Attia *et al.,* 2011).

Also, the findings listed in the same table (6) indicated that the treated bucks with BP increased significantly (P<0.0001) the concentration of T3 (ng/dl) hormone than that of the control. This increase could reflect the better predicted metabolic functions, due to the increased T3 concentration, which antagonizes the hypothyroid state, induced by the adverse stressful effect of heat stress.

These findings agree with those of Elnagar *et al*., (2010), which indicated that the T3 hormone concentration in growing rabbits, orally given royal jelly once a week at 200, 400 or 800 mg/kg BW increased significantly than those of the control.

The obtained findings showed no significant differences in liver enzymes, immune responses and hormonal estimates due to the interaction between rabbit line and BP treatment.

CONCLUSION

The achieved results could be concluded as follow

1- The means of total feed intake for Moshtohor were significantly improved than those of V-line bucks, while those of BWG, FCR, and PI were insignificantly affected.

2- The means of glucose, total lipids, liver enzymes and T3 hormone were significantly increased than those of the V-line.

3- Treating rabbit bucks with 250 and 500mg BP / buck improved FBW, BWG, and PI and reduced TFI, resulting in improving feed conversion ratio.

4- The liver enzymes, immunological responses, and physiological estimates of treated rabbit bucks were significantly improved than those of the control bucks.

Conclusively, it could be concluded that treating V-line and Moshtohor rabbits with 250 and 500mg BP/ buck, is highly recommended without any adverse effect on growing rabbits, during the summer season.

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الاداء الإنتاجي، مكونات الدم و بعض المقاييس الفسيولوجية لذكور الارانب المعاملة بحبوب اللقاح تحت الظروف الحارة السائدة فى اسيوط

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استهدفت هذه التجربة دراسة المعاملة بحبوب اللقاح على الاداء الانتاجى وبعض المقاييس الهيماتولوجية والفسيولوجية لذكور الأرانب تحت الظروف المناخية الحارة السائدة فى اسيوط خلال فصل الصيف.

استخدم فى هذه التجربة عدد ٣٠ ذكر أرنب بواقع (١٥ ذكر V-Line و ١٥ ذكر مشتهر) عند عمر ١٤ اسبوع ، والتي قسمت إلى ثلاث مجاميع متساوية. ولقد تم تغذية ذكور المجموعة الاولى (الكنترول) على عليقة التجارية، بينما غذيت مثيلاتها بالمجموعتين الثانية والثالثة على نفس العليقة مع إعطائها حبوب اللقاح في كبسولات جيلاتينية تحتوى على ٢٥٠ و ٥٠٠ملجم/ ذكر على التوالي. ولقد تم إسكان جميع الذكور بصورة فردية فى بطاريات مجلفنة تحت نفس الظروف الرعائية والصحية.

ولقد أوضحت النتائج وجود فروق معنوية بين ارانب الـ V-Line والمشتهر فى كمية الغذاء المستهلك (جم)، عدد كرات الدم الحمراء (١٠^{٦})، نسبة البروتين الكلى (جم/ديسيلتر)، مستوى الجلوكوز (ملجم/ديسيلتر)، الليبيدات الكلية(جرام/لتر)، انزيم الكبد ALT (وحدة دولية/لتر)، المقاييس المناعية (ملجم/ديسيلتر) وتركيز هرمون التراى ايودوثيرونين(نانوجرام/ديسيلتر).

هذا ولم توجد فروق معنوية بين ارانب الـ V-Line والمشتهر فى صفات الاداء الانتاجى، وتركيز الهيموجلوبين (جم/ديسيلتر)، والهيماتوكريت (%)، الكولسترول (ملجم/ ديسيلتر)، الكفاءة الكلية لمضادات الأكسدة (مل مول/لتر)، انزيم الكبد AST (وحدة دولية/لتر)، الهرمون المنبه لنمو الحويصلات المبيضية (نانو جرام/مل) وهرمون التبويض (MIU/ml).

ولقد أوضحت النتائج أن المعاملة بحبوب اللقاح بالمستويين ٢٥٠ و ٥٠٠ ملجم/ ذكر قللت معنويا من كمية الغذاء المستهلك بحوالى ٤,٤٥ و ٨,٤٨ %، بينما ازدادت

معنوياً متوسطات وزن الجسم (جم)، ومعدل الزيادة اليومية (جم) ومعدل النمو (%) (عند مستوى ٥%).

ولقد تفوقت الذكور المعاملة بحبوب اللقاح فى مستويات الهيموجلوبين و الهيماتوكريت وعدد كرات الدم الحمراء والخلايا الليمفاوية (%) بالمقارنة بمثيلاتها في مجموعة الكنترول.

ولقد ازدادت معنوياً مستويات الالبيومين (ملجم/ديسيلتر)، الجلوبيولين (ملجم/ديسيلتر) و الجلوكوز (ملجم/ديسيلتر) بالإضافة إلى الكفاءة الكلية لمضادات الأكسدة (مل مول/لتر)، المقاييس المناعية (ملجم/ديسيلتر) بالذكور المعاملة بحبوب اللقاح عند مستوى معنوية (١ او ٥%)، بينما انخفضت معنوياً مستويات الكولسترول (ملجم/ ديسيلتر)، والليبيدات الكلية (جم/لتر) وانزيمات الكبد (وحدة دولية/ لتر) (عند مستوى ٥%) بالمقارنة بذكور مجموعة الكنترول.

ولقد تحسن معنوياً ($P<0.01$) تركيز هرمون التستستيرون (نانوجرام/مل)، الهرمون المنبه لنمو الحويصلات المبيضية (نانو جرام/مل) وهرمون التبويض (MIU/ml) فى الذكور المعاملة بحبوب اللقاح بالمقارنة بمثيلاتها بمجموعة الكنترول.

الخلاصة ، يمكن ان نخلص الى ان معاملة ذكور الارانب المرباة تحت الظروف المناخية الحارة بحبوب اللقاح عند مستوى ٢٥٠ او ٥٠٠ملجم قد أدت إلى تقليل كمية الغذاء المستهلك، بينما أدت إلى تحسين مقاييس الدم والاستجابة المناعية وبعض المقاييس الفسيولوجية.

مفاتيح البحث: حبوب اللقاح ، ذكور الأرانب، الأداء الإنتاجي، الاستجابة المناعية ، المقاييس الفسيولوجية.