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Effect of Stocking Density and Dietary Phytobiotics on Growth Performance in Rabbit During Summer Season

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The aim of this study was to investigate the effects of different stocking density and dietary phytobiotic on growth performance, body temperature, carcass traits and economic efficiency of growing APRI- line rabbits under heat stress condition. One hundred and eight APRI-line rabbits were divided and assigned randomly into nine groups of 5 weeks of age (620 ± 6g), each group with 12 rabbits. The experimental design was factorial 3 x 3, whereas three stocking densities (2, 4 and 6 rabbit/cage) and three levels of dietary phytobiotic (0, 0.5 and 1% lycopene). Results showed that the highest body weight was found in treatment 2 rabbits/ cage and rabbit fed diet with 1% lycopene. The best feed conversion ratio was found in treatment 2 rabbits /cage (3.32), followed by 4 rabbits/ cage (3.43), while the poorest value was determined in treatment 6 rabbits/ cage (3,68). The economic efficiency was decreased from 1.17 to 0.96 as the number of rabbits increased from 2 to 6 in the cages. Therefore, it could be concluded that under heat stress, raising rabbits in cages with low density and supplemented with 1% lycopene in diet gave the best productive performance and improved the economical efficiency. At the same time, raising rabbits in low density, permits for somewhat motor activity and social life which reflect on the meat quality and increasing the selling price.

Keywords: Density, Phytobiotic, Rabbit, Summer Season, Heat stress

Introduction

In animal husbandry, the requirement of efficient and safe production taking animal welfare and environmental viewpoints into account is gaining importance world-wide. Rabbit's production demands great quantity of labours to create an adequate environment in relation to both hygiene and comfort that allows them better performance on each physiological stage. El-Raffa (2004) indicated some indispensable requirements to achieve an ideal production in hot climates: high race efficiency productive, suitable sheds, comfortable cages, granulated and balanced food, suitable water, as well as a good hygiene and managing program, to avoid heat stress. The increase of animals per cage reduces investment costs in cages and equipments, but it worsens animal performance (Mbanya et al., 2004). The European Food and Safety Authority (EFSA) (2005) recommended a minimum surface of 625 cm^2/ rabbit and not more than 40 kg/ m^2 at the end of fattening, in order to avoid disturbances in rabbit behavior. However, the behavior of rabbits depends on their age. Rabbits at the end of fattening preferred lower densities, and when caged at high densities spent less time for eating (Morisse and Maurice, 1997). Densities higher than 19 rabbit/m^2 reduced feed intake and growth rate, with no effect on feed efficiency and mortality (Maertens & De Groote, 1984 and Aubret & Duperray, 1992). Facilities more used in tropical conditions are open sheds, where weather control is very difficult which increases heat stress during fattening period. In these conditions the increase of cage density on performance might be more important than in European conditions. In this respect, Nieves et al. (1996), Andréa et al. (2004) and Mbanya et al. (2004) recommend 5 – 16 rabbits/m^2 as an adequate range for tropical condition. Nevertheless none of them describes climate conditions.

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Lycopene is an open-chain unsaturated carotenoid reported to be an efficient antioxidant. It is the pigment molecule that imparts the red color to some fruits and is found in high concentration in tomatoes and tomato products, watermelons, red grapefruits, and guava (Omoni and Aluko, 2005). Experimental studies have shown that it has many important bioactivities, *e.g.,* quenching singlet oxygen, eliminating reactive oxygen species, blocking lipid peroxidation, suppressing cell reproduction, reinforcing immunity, and inducing gap junction intercellular communication (Rissanen et al., 2003 and Omoni & Aluko, 2005). It is one of the most popular research topics in nutrition and pharmaceutics (Rissanen et al., 2003 and Roldan & Luque, 2007). However, few quantitative experimental studies of the preventive effect of lycopene on atherosclerosis have been reported, especially in vivo. Therefore, the aim of this study was to investigate the effects of different stocking density (2, 4 and 6 rabbit/ cage) and dietary phytobiotic (0, 0.5 and 1% lycopene) on growth performance, carcass traits, some blood parameters and gene expression of muscle of growing APRI-line rabbits under heat stress conditions.

Materials and Methods

This study was carried out at the Rabbits Farm of Sakha Station, Animal Production Research Institute, Agriculture Research Center, Egypt, during the period from June until September 2016. One hundred and eight APRI line rabbits were divided and assigned randomly into nine experimental groups of 5 weeks of age, (620±6.0 g). Rabbits were similar, with respect to body weight and sex.

The experimental design was factorial 3 x 3, whereas three stocking density (2, 4 and 6 rabbit/ cage) and three levels of dietary phytobiotic (0, 0.5 and 1% lycopene). So, nine experimental treatments were as follow:

1- G1: Stocking density of 2 rabbits per cage (800 cm^2/ rabbit) and rabbits fed basal diet without any supplementation.
2- G2: Stocking density of 4 rabbits per cage (400 cm^2/ rabbit) and rabbits fed basal diet without any supplementation.
3- G3: Stocking density of 6 rabbit per cage (267 cm^2/ rabbit) and rabbits fed basal diet without any supplementation.
4- G4: Stocking density of 2 rabbits per cage (800 cm^2/ rabbit) and rabbits fed basal diet supplemented with 0.5% lycopene.
5- G5: Stocking density of 4 rabbits per cage (400 cm^2/ rabbit) and rabbits fed basal diet supplemented with 0.5% lycopene.
6- G6: Stocking density of 6 rabbits per cage (267 cm^2/ rabbit) and rabbits fed basal diet supplemented with 0.5% lycopene.
7- G7: Stocking density of 2 rabbits per cage (800 cm^2/ rabbit) and rabbits fed basal diet supplemented with 1% lycopene.
8- G8: Stocking density of 4 rabbits per cage (400 cm^2/ rabbit) and rabbits fed basal diet supplemented with 1% lycopene.
9- G9: Stocking density of 6 rabbits per cage (267 cm^2/ rabbit) and rabbits fed basal diet supplemented with 1% lycopene.

Animals were housed in flat-deck cages of 400 × 400 × 300 mm (0.16 m^2) equipped with one nipple drinker and one hopper feeder (30 cm available) each one. The batteries were arranged in rows in a windowed house naturally ventilated. A cycle of 16 hours of light and 8 hours of dark were used throughout the experiment. All rabbits were kept under the same managerial conditions. Feed and water were offered *ad libitum*. Individual live body weight and feed intake were recorded, while average gain and feed conversion ratio were calculated weekly from 5 to 13 weeks of age. Mortality and the clinical health status of all rabbits were monitored daily and mortality percentage was calculated.

At the end of growing period, six rabbits (3 males +3 females) of 13 weeks of age were taken randomly from each treatment, fasted for 12 hr, weighed, slaughtered and weighed after complete bleeding, skinned and eviscerated. Immediately after evisceration, weight of the dressed carcass free from any internal organs was recorded. Stomach, small intestine, caecum and large intestine weights (full and empty) and pH were taken. Carcass characteristics were evaluated as described by Fernell et al. (1990). Caecal contents were dried at 60^{o}C for 2 days, ground and analyzed according to the method of AOAC (1995).

Immediately after slaughtering, blood samples of growing rabbits were collected from six rabbits/ each group. The samples were collected into dry clean centrifuge tubes. Non-coagulated blood was tested shortly after collection for determination blood pictures including, red blood cells count (RBCs, $10^6/mm^3$), white blood cells count (WBCs, $10^3/mm^3$); different subclasses of WBC's (lymphocyte, neutrophils and monocytes percentages) and hemoglobin (Hb, g/dl) concentration according to Drew et al. (2004).

A digestibility trail was performed on thirty five male APRI-line rabbits, at least three months old and similar in body weights, to determine the apparent nutrient digestibility of the seven experimental groups (5 males for each diet). Animals were housed in metabolism cages that allowed separation of faeces and urine. Faeces produced daily were collected in polyethylene bags and stored at -20ºC (Perez et al., 1995) for five consecutive days according to the European reference method for rabbit digestion trials. At first, hard and soft faeces were dried at 60ºC for 48 hr. to determine DM, while DM of diets were performed using an air oven at 135ºC for 2 hr. Chemical analysis were carried out for diets, hard and soft faeces samples, according to methods of AOAC (1995) for ash, CP, CF and EE. Gross energy was determined in an adiabatic bomb calorimeter in Animal and Poultry Nutrition and Production Department, National Research Center, Dokki, Cairo, Egypt. Nutrient digestion coefficient and nutritive values in terms of total digestible nutrient (TDN), digestible crude protein (DCP) and digestible energy (DE) were calculated as described by Perez et al. (1995).

Data were subjected to analysis of variance, using the general linear GLM procedure of SAS program (SAS, Institute, Inc., 2000). The application of the least significant ranges among the different treatment means was done according to Duncan (1955). Data of Growth performance, carcass traits, meat chemical composition, blood hematological values and blood parameters were analyzed by factorial design (9 groups x 8 sampling times), while live body weight and feed intake were analyzed using one way ANOVA.

Results and Discussion

Rectal temperature

Data in Table 2 showed that there was a significant difference in the rectal temperature among the treatments 2, 4 and 6 rabbit/cage density started from week 7 of age up to end of experimental (12 week). The minimum rectal temperature 39.01˚C for treatment 2 rabbit/ cage during 6 and 8 weeks of age, whoever, the maximum rectal temperature was 40.01 for 6 rabbit/ cage on 12 weeks of age. Data in Table 2 also showed that there was a significant difference in the rectal temperature among 0, 0.5 and 1.0% lycopene only on 5, 6 and 10 week of age. These results agreed with that of Abd El–Hakeam *et al.* (1991) who recorded that the exposure of rabbits to high air temperature significantly increased the respiratory rate and rectal one. This may be attributed to heat production, which was increased by heat stress as a result of increasing the metabolic rate resulting in hyperthermic animal, which try to alleviate this hyperthermia via hyperpenea (Shafie *et al.,* 1982), which represents for about 30% of total heat dissipation.

Growth performance parameters

The effect of stocking density and phytobiotic on growth performance of growing APRI-line rabbits from 5 to 13 weeks of age is presented in Table 3. The highest body weight and daily weight gain were observed in treatment 2 rabbits/ cage and fed diet with 1 % lycopene. While the lowest body weight and daily weight gain were observed in treatment of 6 rabbits/ cage and fed diets with 0 or 0.5 lycopene. Relative growth rate was improved by 12.8% in the treatment 2 rabbits/ cage as compared with treatment 6 rabbits/cage ($P<0.05$). Also, relative growth rate was increased by 5.85% in the rabbits feed diet with 1% lycopene as compared with those fed control diet ($P < 0.05$). Results reported here are in agreement with data obtained by Verga *et al*. (1995) who tested 168 hybrid rabbits from the age of 30 days to slaughter, at the age of 90 days. Body weights in the 2nd half of the experiment were significantly higher in the lower stocking density (11.8 rabbits/ m^2) than in the higher density group (16.7 rabbits/ m^2). Kolte *et al*. (1996) studied stocking density and its effect on growth of young meat type rabbits (New Zealand White) under Vidarbha agro climatic conditions. Three rabbits were housed in a cage providing 8.3 rabbits/m2 and 11.1 rabbits/m^2 for each. They were kept in the cages from 6 to 12 weeks of age. Stocking density of 8.3 rabbits/ m^2 had significantly higher body weights. Total body weight reduction in the group with 4 rabbits/ cage may be explained by lower fed intake and lower physical activity due to the crowding stress, as observed by Morisse and Maurice (1997) who also reported that reducing stocking density from 20-23 to 15-16 rabbits/ m^2 significantly improved growth performance. Also, Aboegla, El-Samra *et al.* (2013) reported that significantly higher total body weight was observed in rabbits stocked at 2 rabbits/ cage 2103.9 g, followed by those at 1, 3 and 4 rabbits/cage 2083.3, 1997.4 and 1916.1 g; respectively ($P \leq 0.05$).

TABLE 1. Composition and chemical analysis of basal diet

Ingredients	%	Chemical analysis (% as DM)	%
Berseem hay	30.05	Dry matter (DM)	85.81
Barley grain	24.60	Crude protein (CP)	17.36
Wheat brain	21.50	Organic matter (OM)	91.42
Soybean meal (44% CP)	17.50	Crude fiber (CF)	12.37
Molasses	3.00	Ether extract (EE)	2.230
Limestone	0.95	Digestable energy(DE, kcal/kg)(2)	2412
Di-calcium phosphate	1.60	Calcium(2)	1.243
Sodium chloride	0.30	Total phosphorus(2)	0.808
Mineral-vitamin premix(1)	0.30	Methionine(2)	0.454
DL-Methionine	0.20	Lysine(2)	0.862
Total	100		

1- One kilogram of mineral–vitamin premix provided: Vitamin A, 150,000 UI; Vitamin E, 100 mg; Vitamin K3, 21mg; Vitamin B1, 10 mg; VitaminB2, 40mg; Vitamin B6, 15mg; Pantothenic acid, 100 mg; Vitamin B12, 0.1mg; Niacin, 200 mg; Folic acid, 10mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Fe, 0.3mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1mg; and Zn, 450mg.
2- Calculated according to De Blas and Mateos (1998).

TABLE 2. Effect of stocking density and phytobiotic on body temperature of APRI-line rabbits from 6 to 13 weeks of age

Week (age)	Stocking density (rabbit/ cage)			Phytobiotic (%)			P-value		
	2	4	6	0	0.5	1.0	D	P	D x P
5	39.35±0.114	39.38±0.087	39.35±0.160	39.28±0.115[ab]	39.23±0.113[b]	39.57±0.124[a]	0.9812	0.0796	0.0563
6	39.01±0.094	39.12±0.063	39.19±0.129	38.99±0.108[b]	39.03±0.088[b]	39.29±0.085[a]	0.3883	0.0539	0.2181
7	39.18±0.096[ab]	39.01±0.075[b]	39.31±0.107[a]	39.17±0.082	39.13±0.096	39.21±0.115	0.0822	0.8211	0.0801
8	39.01±0.120	39.09±0.079	39.21±0.138	39.06±0.147	39.09±0.097	39.15±0.099	0.4273	0.8492	0.0402
9	39.31±0.096[b]	39.55±0.077[b]	39.89±0.100[a]	39.52±0.078	39.65±0.136	39.57±0.111	0.0005	0.6124	0.7555
10	39.13±0.099[b]	39.15±0.077[b]	39.73±0.107[a]	39.62±0.127[a]	39.17±0.084[b]	39.22±0.107[b]	0.0001	0.0006	0.5923
11	39.33±0.069[b]	39.33±0.067[b]	39.64±0.069[a]	39.40±0.063	39.46±0.090	39.45±0.079	0.0041	0.8164	0.4701
12	39.57±0.081[b]	39.83±0.060[ab]	40.01±0.113[a]	39.82±0.097	39.82±0.096	39.77±0.104	0.0069	0.8921	0.6739

[a, b, c,] Means in the same row with different superscripts are significantly different (P<0.05), D: Stocking density, P: Phytobiotic.

TABLE 3. Effect of stocking density and phytobiotic on growth performance of APRI-line rabbits from 5 to 13 weeks of age

Parameter	Stocking density (rabbit/ cage)			Phytobiotic (%)			P-value		
	2	4	6	0	0.5	1.0	D	P	D x P
Initial body weight (g)	503.6±9.50	504.2±12.81	503.8±6.37	503.8±9.67	504.9±10.82	503.1±8.20	0.999	0.992	0.998
Final body weight (g)	1895.6±37.6[a]	1710.0±25.4[b]	1579.9±19.9[c]	1611.1±33.3[b]	1672.8±32.2[b]	1743.8±24.6[a]	0.000	0.005	0.037
Daily weight gain (g)	24.86±0.572[a]	21.52±0.345[b]	19.22±0.338[c]	19.77±0.552[c]	20.86±0.527[b]	22.16±0.388[a]	0.000	0.000	0.231
Feed intake (g/d)	81.77±0.671[a]	73.30±0.495[b]	69.68±0.451[c]	70.82±0.770[c]	73.05±0.760[b]	74.83±0.995[a]	0.000	0.001	0.143
Feed conversion ratio	3.321±0.085[b]	3.434±0.056[b]	3.688±0.071[a]	3.667±0.096[a]	3.561±0.07[ab]	3.399±0.052[b]	0.001	0.196	0.099
Relative growth rate	115.9±1.056[a]	109.2±1.314[b]	103.1±1.118[c]	104.3±1.634[b]	107.1±1.57[ab]	110.4±1.052[a]	0.000	0.021	0.595
Performance index (%)	58.1±2.365[a]	50.7±1.586[b]	44.1±1.279[c]	45.7±2.028[b]	48.2±1.786[ab]	52.0±1.410[a]	0.000	0.087	0.147
Mortality (%)	-	-	-	-	-	-	-	-	-

The effects of the stocking density and phytobiotic on feed intake (g/ rabbit/ week) of APRI-line rabbits from 6 to 13 weeks of age on feed intake are presented in Table 3. It could be noted that feed intake was decreased from 81.8 to 59.3 g/ d as the number of rabbits increased from 2 to 6 rabbits per cage (P< 0.001). Also, daily feed intake was increased by increasing the level of lycopene increased from 0 to 1% in the rabbit diets (P< 0.001). These results are in accordance with Villalobos *et al.* (2008) who reported that average feed intake decreased when the density increased from 6 to 12, 18 and 24 rabbits/ m^2. Moreover, Szendrő and Dalle Zotte (2011), based on several studies, concluded that that optimal stocking density is 16-18 rabbits/ m^2, depending on final body weight of rabbits. The best value of feed conversion ratio was found in the treatment 2 rabbits per cage (3.32) follow by treatment 4 rabbits per cage (3.43) while, the poorest value in treatment 6 rabbits percentage (3.69). No mortality could be observed during the experimental period. Results reported here are in agreement with those reported by Princz *et al.* (2008) who illustrated that stocking density did not affect mortality of the growing rabbits.

Carcass traits

Table 4 represents the results concerning the effect of stocking density and phytobiotic on carcass traits of growing APRI-line rabbits. The carcass percentage were decreased (P<0.001) from 53.3 to 50.8% as the number of rabbits increased from 2 to 6 per cage, but carcass percentages were increased (P<0.001) from 50.9 to 53.8% as the level of lycopene increased from 0 to 1% in the rabbits diets. Similarly, Lazzaroni *et al*. (2009) found that decrease of fat deposit in the pen-housed rabbits (higher disposable space) compared with the rabbits reared in the individual cages. However, Yakubu & Adua (2010) and Baiomy (2012) observed no effect of stocking density on carcass characteristics of fattening rabbits. Moreover, Lambertini *et al.* (2001) evaluated the effects of two stocking densities (8 or 16 rabbits/ m^2) and found that hot carcass weight of rabbits stocked at the lower density was significantly higher than that of rabbits kept at the higher stocking density.

Gastrointestinal tract percentage BW was increased (P<0.001) from 12.8 to 14.8% as the number of rabbits increased from 2 to 6 rabbits per cage. But, it was decreased (P<0.001) from 14.7 to 12.7% by increasing the level of lycopene from 0 to 1% in rabbits diets. No significant differences could be observed among treatment in pH values (stomach, small intestine, ceacum and large intestine).

Meat chemical composition

Results concerning the effect of stocking density and phytobiotic on meat chemical composition of growing APRI-line rabbits are represented in Table 5. Dry matter percentage of meat were significantly decreased (P <0.001) by increasing the number of rabbits from 2 to 6 rabbits per cage, while it increased (P <0.001) as the level of lycopene increased from 0 to 1% in the rabbits diets. Crude protein percentages was decreased (P <0.001) by increased the number of animals from 2 to 6 rabbit per cage while, it was increased from 64.8 to 70.4% as the level of lycopene increased from 0 to 1% in the rabbit diets. However, ether extract (%) of meat was increased (P <0.001) by increasing the number of animals from 2 to 6 rabbits per cage. While it was decreased (P <0.001) from 23.3 to 20.7% as the level of lycopene increased from 0 to 1.0 in the rabbit diets. Similarly, Ignatova *et al.* (2009) found that probiotic addition (*Lactobacillus* and *Bifidobacterium* strains at 0.1% in the diet) reduced the fat content of the chicken meat.

Economic efficiency

Data of the growth performance were subjected to economic study (Table 6). The results showed that the total feed intake (kg/head) were 4.579, 4.105 and 3.902 for stocking density 2, 4 and 6, respectively. However, the corresponding value for phytobiotic 0, 0.5 and 1.0 were 3.966, 4.091 and 4.191, respectively. The price /kg diet (LE) were 3.51 for 2, 4 and 6 stocking density and 3.46, 3.51, 3.56 for phytobiotic 0, 0.5 and 1.0, respectively. Total feed cost was reduced with increasing stocking density (16.077, 14.414 and 13.698) 2, 4 and 6, respectively. While, total fed cost (LE) for phytobiotic were 13.723, 14.359 and 14.918, respectively. The average weight gain (kg/ head) were 1.392, 1.206 and 1.076 for 2, 4 and 6 stocking density and 1.107, 1.167 and 1.241 for phytobiotic 0, 0.5 and 1.0, respectively. The net revenue (LE) was 18.721, 15.732 and 13.204 for 2, 4 and 6 stocking density and 13.961, 14.839 and 16.099 for phytobiotic 0, 0.5 and 1.0, respectively. The economic efficiency was decreased from 1.17 to 0.96% as the number of rabbits increased from 2 to 6 per cage. While, it was increased from 1.02 to 1.08% by increased the level of lycopene from 0 to 1% in the rabbit diets.

TABLE 4. Effect of stocking density and phytobiotic on carcass traits of growing APRI-line rabbits

Parameter	Stocking density (rabbit/ cage)			Phytobiotic (%)			P-value		
	2	4	6	0	0.5	1.0	D	P	D x P
Carcass (%)	53.3±0.540[a]	52.7±0.372[a]	50.8±0.707[b]	50.9±0.589[c]	52.2±0.599[b]	53.8±0.459[a]	0.000	0.000	0.686
Dressing Percent:									
Without head (%) BW	57.6±0.631[a]	56.8±0.394[a]	54.8±0.757[b]	54.7±0.592[c]	56.3±0.543[b]	58.2±0.522[a]	0.000	0.000	0.641
With head (%) BW	64.2±0.543[a]	63.6±0.467[a]	61.3±0.827[b]	61.3±0.663[c]	62.9±0.542[b]	64.9±0.518[a]	0.000	0.000	0.718
Kidney (%) BW	0.650±0.021	0.705±0.019	0.715±0.02	0.667±0.02	0.709±0.02	0.694±0.02	0.145	0.479	0.461
Heart (%) BW	0.356±0.042	0.358±0.021	0.439±0.03	0.386±0.04	0.379±0.02	0.387±0.04	0.210	0.983	0.678
Liver (%) BW	3.30±0.126[a]	3.00±0.063[b]	2.82±0.047[c]	2.83±0.073[c]	3.04±0.080[b]	3.26±0.115[a]	0.0001	0.0002	0.1661
Giblets part (%) BW	4.31±0.121[a]	4.07±0.055[b]	3.97±0.062[b]	3.88±0.045[c]	4.12±0.079[b]	4.34±0.086[a]	0.0005	0.0001	0.1204
Abdominal fat (%) BW	1.27±0.084[a]	1.16±0.060[a]	0.91±0.057[b]	0.92±0.052[c]	1.12±0.056[b]	1.31±0.084[a]	0.000	0.000	0.686
GIT (%)BW[(1)]	12. 8±0.271[b]	13.3±0.646[ab]	14.8±0.842[a]	14.7±0.780[a]	13.4±0.48[ab]	12.7±0.614[b]	0.086	0.100	0.935
Values of pH:									
Stomach	3.11±0.159	3.34±0.273	3.62±0.179	3.78±0.203[a]	3.34±0.181[ab]	2.96±0.478[b]	0.1699	0.0180	0.5094
Small Intestine	6.61±0.048	6.67±0.047	6.76±0.058	6.68±0.040	6.67±0.062	6.68±0.062	0.2230	0.9951	0.8201
Caecum	6.66±0.050	6.61±0.026	6.62±0.088	6.64±0.073	6.62±0.064	6.62±0.040	0.885	0.963	0.742
Large Intestine	6.19±0.325	6.31±0.046	6.34±0.058	6.32±0.060	6.44±0.044	6.08±0.314	0.838	0.413	0.468

[a, b, c,] Means in the same row the different superscripts are significantly different ($P<0.05$), D: Stocking density, P: Phytobiotic, [(1)]GIT: Gastrointestinal tract.

TABLE 5. Effect of stocking density and phytobiotic on meat chemical composition of growing APRI-line rabbits (on dry matter basis)

Nutrient	Stocking density (rabbit/ cage)			Phytobiotic (%)			P-value		
	2	4	6	0	0.5	1.0	D	P	D x P
DM	29.7±0.413[a]	28.9±0.428[b]	27.8±0.383[c]	27.5±0.327[c]	28.8±0.320[b]	30.1±0.30[a]	0.0001	0.0001	0.9580
Ash	4.56±0.074[b]	4.73±0.093[b]	5.03±0.136[a]	5.04±0.116[a]	4.74±0.103[b]	4.54±0.08[b]	0.0037	0.0024	0.9418
CP	68.9±0.780[a]	67.7±0.987[a]	65.7±1.055[b]	64.8±0.680[c]	67.1±0.738[b]	70.4±0.56[a]	0.0012	0.0001	0.7617
EE	21.0±0.512[c]	22.2±0.399[b]	23.4±0.592[a]	23.3±0.481[a]	22.6±0.431[a]	20.7±0.49[b]	0.0009	0.0002	0.8424

[a, b, c,] Means in the same row the different superscripts are significantly different ($P<0.05$), D: Stocking density, P: Phytobiotic

TABLE 6. Effect of stocking density and phytobiotic on net revenue of growing APRI-line rabbits

Parameter	Stocking density (rabbit/ cage)			Phytobiotic (%)		
	2	4	6	0	0.5	1.0
Total feed intake (kg /head)	4.579	4.105	3.902	3.966	4.091	4.191
Price /kg diet (L.E.)	3.51	3.51	3.51	3.46	3.51	3.56
Total feed cost (L.E.)	16.077	14.414	13.698	13.723	14.359	14.918
Average weight gain (kg/ head)	1.392	1.206	1.076	1.107	1.167	1.241
Selling price (L.E.)[(1)]	34.799	30.146	26.603	27.684	29.198	31.017
Net revenue (L.E.)[(2)]	18.721	15.732	13.204	13.961	14.839	16.099
Economic efficiency [(3)]	1.165	1.091	0.964	1.017	1.033	1.079

Other conditions like mortaility (%) and mangement are fixed.

- Ingredients price (L.E. per ton) at 2016were: 3500 barley; 3600 yellow corn; 2000 berseem hay; 2800 wheat bran ; 6500 soybean meal (44%) ; 25 limestone ; 9000 premix ; 21000 methionine ; 1000 di-calcium phosphate ; 10000 lycopene; 1000 salt.
- Adding 100 L.E. /ton for pelliting.

[(1)] Price of kg live body weight was 25 L.E.

[(2)] Net revenue= Selling price – total feed cost.

[(3)] Economic efficiency = Net revenue/ total feed cost.

Conclusion

It could be concluded that under heat stress, raising rabbits in cages with low density and supplementing of 1% lycopene in diet gave the best productive performance and improving economical efficiency. At the same time, raising rabbits in low density, permits for somewhat motor activity and social life which reflect on the meat quality and increasing the selling price.

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