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ALLEVIATION OF HEAT-STRESSED GROWING RABBITS BY USING SOME FEED ADDITIVES UNDER EGYPTIAN CONDITION

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SUMMARY

The experiment was carried out in the Rabbitry Farm of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, during December, 2000 to January, 2001 (as winter season), and during July to August, 2001 (as summer season). One hundred and forty male New Zealand White rabbits at 35 day old, with nearly equal live body weight at the beginning of the experiment were randomly allotted to 14 treatment groups, of 10 rabbits each. Seven rabbit groups were reared during the summer season conditions (as the heat stress season), while the other seven groups were reared during the winter season. Within each season, the first group was fed on the control diet (without supplementation), while the second group was fed on diet supplemented with 100 µg thyroxin /kg diet, the third was fed on diet supplemented with 50 µg thyroxin / kg diet, the fourth group was fed on diet supplemented with 1.5 g methionine / kg diet, the fifth group was fed on diet supplemented with 0.75 g methionine / kg diet, the sixth group was fed on diet supplemented with 1.5 g lysine / kg diet, the seventh group was fed on diet supplemented with 0.75 g lysine / kg diet. Exposed rabbits to heat stress reduced the growth rate and feed efficiency. Supplemented heat stressed rabbit diets with methionine, lysine and thyroxin improved the rabbit performance.

Key Words: *rabbit, heat stress, methionine, lysine and thyroxin , growth performance.*

INTRODUCTION

In tropical zones one of the most important stress factors are high temperatures (30 to 35°C) which have a deleterious effect on production (Lebas, 1983). The combination of high temperatures and high humidity is responsible for a number of important changes in the normal physiology which gives rise to low productivity and anoestrus (González, 1975). High environmental temperatures, especially in presence of excessive humidity, determine considerable changes in the main physiological parameters of the rabbits, and significant variations to the energy, protein and mineral metabolism (Daader *et al.*, 1989, Habeeb *et al.*, 1992, Marai and Habeeb, 1994 and Marai *et al.*, 1994 a and b).

Growth enhancers can be defined as substances or products (chemicals) other than a dietary nutrient that increase growth rate and/or feed conversion in healthy animals fed a balanced diet adequate in all nutrients. Such growth stimulants can be added to the diet, injected or implanted into farm animals at one time or another (Marai, 1997).

The present experiment aimed to study effects of hot climate conditions and its amelioration by using of growth enhancers on New Zealand White male rabbits, under the Egyptian conditions.

MATERIALS AND METHODS

The experiment was carried out in the Rabbitary Farm of the Department of Animal Production Faculty of Agriculture, Zagazig University, Zagazig, One hundred and forty male New Zealand White rabbits, 35 day old, with nearly equal live body weight at the beginning of the experiment were randomly allotted to 14 treatment groups, of 10 rabbits each. Seven rabbit groups were reared during the winter season conditions, while the other seven groups were reared during the summer season (as the heat stress season). Within each season, the first group was fed on the control diet (without supplementation), while the second group was fed on diet supplemented with 100 µg thyroxin /kg diet, the third fed on diet supplemented with 50 µg thyroxin / kg diet, the fourth group fed on diet supplemented with 1.5 g methionine / kg diet, the fifth group fed on diet supplemented with 0.75 g methionine / kg diet, the sixth group fed on diet supplemented with 1.5 g lysine / kg diet, the seventh group fed on diet supplemented with 0.75 g lysine / kg diet. All rabbits fed diets containing 30.0% alfalfa hay, 7.0% barley, 12.0% soybean meal, 32.0% wheat bran, 14.0% yellow corn, 3.0% molasses, 1.4% limestone, 0.3% sodium chloride salt and 0.3% vitamin and mineral premix. The chemical composition of the experimental diets were 16.54% crude protein, 14.57% crude fibre and 2525 kcal metabolic energy. The rabbits were fed on pelleted ration *ad libitum*. Rabbits in all groups were kept under the same managerial and hygienic conditions. The rabbits were housed in batteries provided with feeders and automatic drinkers. Feed consumed was recorded weekly. Feed conversion ratio was calculated as grams of food to produce one gram gain for each treatment groups.

The temperature-humidity index (THI) was calculated according to LPHSI (1990) by using the formula: THI = (0.55 X RH) X (db°F – 58.0),

Where: db°F = dry bulb temperature and RH = relative humidity percentage/100. The values obtained were then classified as follows: <72= absence of heat stress, 72 -< 78 = moderate heat stress, < 78= severe heat stress.

Economic evaluation was calculated as the following equation (According to Ayyat, 1991), Margin = Return from body gain weight - Feed cost. Other overhead costs were assumed constant. The price of one kg of diet was 0.71 LE, and the price of selling of one kg live body weight of rabbits was 10.0 LE (Egyptian pound). At the end of experimental period five rabbits from each group were randomly selected to collect the blood samples. The blood samples were centrifuged at 3000 rpm for 20 minutes to separate the serum. The collected serum was stored at-20°C until assay. Total protein, albumin, urea-N, creatinine, glucose, total lipids, cholesterol and serum transaminase enzymes (SGPT and SGOT) were estimated in blood serum by colormetric methods using commercial kits. At the end of the experimental period five rabbits from each group were randomly taken for slaughter after being fasted for 12 hours. After complete bleeding, the carcass and some non-carcass components were weighed. The carcass was separated into three cuts (fore-limbs, trunk and hind-limbs). Each of the three cuts was weighed.

The data of live body weight and gain and blood components were statistically analyzed by 2X2X2 factorial experiment (Snedecor and Cochran, 1982) according to the following model: $Y_{ijkll} = \mu + S_i + A_j + SA_{ij} + e_{ijk}$,where, μ = The overall mean, S_i = The fixed effect of ith season (S_i = 1 ... 2), e_{ijkl} = Random error, Aj = The fixed effect of jth dietary supplementation (Aj = 1 ... 2), SAjj = Interaction between ith season andjth dietary supplementation. Slaughter data were analyzed by analysis of covariance according to the following model: Yijkll = μ + + Si + Aj + SAij + b(X-x) + Eijkl , where, μ, Si, Pj, Ok, SAij and E_{ijkl} were defined in the previous model, b = Regression coefficient of Y on X (slaughter weight) and x is the arithmetic means of x's (slaughter weight).

RESULTS AND DISCUSSION

1. Temperature-humidity index

Temperature-humidity index values were estimated as 66.22 and 79.75 during the mild (winter) and hot (summer) climate periods of the year, respectively, indicating absence of heat stress during the mild climate (less than 72) and exposure of the animals to severe heat stress (>78) during the hot climate, in the present study.

All mammals are homeotherms to regulate the body temperature system. Heat stress occurs when an animal has excess body heat that it cannot lose. Endocrine tissues play an integral part in the animal response to stress. The hypothalamus, receives and monitors information about the environment and coordinates the responses through nerves and hormones. From this miniaturized center, the brain controls hormone secretion from pituitary gland and other tissues such as the adrenal glands. These hormones control cardiovascular and renal function, metabolism, and act together with the nervous system to adjust the responses to the environment. When over activated, these systems can cause a deterioration in general health. Basal metabolic rate is the minimum amount of energy required to sustain the body's vital functions. This is the basic level of heat production by the body based solely on the chemical reactions of metabolism. Muscular activity produces heat as a side effect of the work that is done. Dietary Intake causes an increase in metabolic rate as the body works to digest foods (Roussel, 1992, Ruff, 1994 and Coventry and Phillips, 2000).

2. Growth performance

The non-significant difference between the experimental groups for initial body weight indicated that the groups at the beginning of the experiment were homogenous. At 8 weeks of the experimental period, the live body weight was significantly affected (P<0.001) with the year season. Rabbits reared during summer season recorded lower live body weight with 8.65 % at 8 weeks of the experimental period than the rabbit groups which were reared during the winter season (Table 1).

Live body weight at 4 and 8 weeks of the experimental period were affected significantly (P<0.001) with dietary feed additives. Rabbits fed diet supplemented with 100 μg thyroxin per kg diet recorded higher body weight than the other experimental groups at 4 and 8 weeks of the experimental period (Table, 1). The interaction between the year season and dietary feed additives were insignificantly affected live body weight. Rabbits reared during winter season and fed diet supplemented with 100 μg thyroxin per kg diet recorded higher body weight than the other experimental groups at 4 and 8 weeks of the experimental period.

The daily weight gain decreased significantly (P<0.001) in summer than in winter, during 4-8 and 0-8 weeks of experimental period (Table, 1). The reduction values in daily gain were 24.18 and 11.47%, On the other hand, daily body gain during 0-4 weeks of the experimental period did not show any significant affects with year season. The observed depression in growth rate in growing

Table 1: Live body weight (g) & daily body gain (g) of rabbits at different experimental periods as affected by season, feed additives and their interaction.

Items	Live Body Weight			Daily Body Gain		
	W0	W4	W8	W0-4	W4-8	W0-8
Season:						
Winter	573.56±7.91	1291.82±18.14	2038.71±18.68	25.65±0.71	26.67±0.64	26.16±0.37
Summer	565.37±5.88	1296.12±13.76	1862.39±17.29	26.10±0.54	20.22±0.57	23.16±0.33
Significant:	NS	NS	***	NS	***	***
Feed additives						
Without	571.00±14.32	1196.75±21.98	1798.25±39.91	22.35±1.05	21.48±1.43	21.92±0.75
T1	565.79±12.06	1395.00±24.30	2042.37±36.78	29.61±0.96	23.12±1.38	26.37±0.69
T2	567.11±12.23	1202.89±26.22	1913.68±34.34	22.71±1.07	25.38±1.18	24.05±0.62
M1	568.95±12.48	1327.11±24.80	1994.74±32.52	27.08±0.99	23.84±1.45	25.46±0.60
M2	573.33±13.35	1334.17±33.76	1934.44±40.18	27.17±1.36	21.44±1.30	24.31±0.83
L1	567.00±14.40	1302.25±25.44	2007.25±33.98	26.26±0.64	25.18±1.00	25.72±0.66
L2	573.33±13.64	1307.22±27.38	1963.33±32.74	26.21±0.10	23.43±1.54	24.82±0.55
Significant:	NS	***	***	***	NS	***
Interaction between season and feed additives:						
Winter:						
Without	577.00±25.83	1213.50±29.25	1914.50±42.14	22.73±1.79	25.04±1.85	23.88±0.99
T1	570.00±18.28	1377.22±33.84	2128.33±54.30	28.83±1.04	26.82±1.83	27.83±0.96
T2	566.00±18.62	1183.50±45.41	1991.00±38.88	22.06±1.75	28.84±0.86	25.45±0.71
M1	576.67±19.84	1321.11±38.67	2085.56±37.42	26.59±1.65	27.30±1.89	26.95±0.86
M2	577.22±22.72	1344.44±62.21	2050.56±49.87	27.40±2.57	25.22±1.46	26.31±1.22
L1	567.50±23.90	1335.50±47.31	2074.50±54.75	27.49±1.67	26.39±1.64	26.91±0.94
L2	581.67±21.75	1283.33±50.38	2041.67±46.55	25.06±1.69	27.08±2.25	26.07±0.78
Summer:						
Without	565.00±13.80	1180.00±33.51	1682.00±44.12	21.96±1.17	17.93±1.56	19.95±0.73
T1	562.00±16.79	1411.00±35.60	1965.00±37.10	30.32±1.62	19.78±1.40	25.05±0.82
T2	568.33±16.62	1224.44±24.03	1827.78±44.25	23.43±1.21	21.55±1.47	22.49±0.79
M1	562.00±16.28	1332.50±33.68	1913.00±36.48	27.52±1.21	20.73±1.70	24.13±0.59
M2	569.44±15.40	1323.89±30.77	1818.33±31.66	26.95±1.09	17.66±1.20	22.30±0.65
L1	566.50±17.45	1269.00±15.81	1940.00±29.52	25.90±0.80	23.97±1.12	24.53±0.78
L2	565.00±17.32	1331.11±22.50	1885.00±29.25	27.36±1.03	19.78±1.28	23.57±0.54
Significant:	NS	NS	NS	NS	NS	NS

T1 = Thyroxin 100 µg/kg diet, T2 = Thyroxin 50 µg/kg diet, M1 = Methionin 1.5 g/kg diet, M2 = Methionin 0.75 g/kg diet, L1 = Lysine 1.5 g/kg diet, L2 = Lysine 0.75 g/kg diet and W = experimental periods by weeks.
NS = Non Significant *** P< 0.001

NZW rabbits as a result to exposure to heat stress in the Egyptian summer is similar to that reported in the same species by Habeeb *et al.* (1994), Marai *et al.* (1994a and 1999), Ayyat *et al.* (1997) and Ayyat and Marai (1997) in rabbits.

Rabbits fed diet supplemented with 100 μg thyroxin per kg diet recorded higher daily body gain weight than the other experimental groups at 0-8 weeks of the experimental period. The value of daily body gain weight at 0-8 weeks of the experimental period of rabbits fed diet supplemented with 100 μg thyroxin, 50 μg thyroxin, 1.5 g methionine, 0.75 g methionine, 1.5 g lysine and 0.75 g lysine / kg diet were increased with 20.30, 9.70, 16.15, 10.90, 17.34 and 13.23%, respectively, than those fed diet without supplementation. The improvement in growth rate due to the amino acids supplementation in rabbit diets may be due to amino acids unbalance in the rations (Omole and Oke, 1980). Amino acids supplementation in diets to achieve the recommended requirements for sulfur amino acids has been reported to increase growth rate and improve feed conversion (Prudhon, 1976 and Spreadbury, 1978). The improvement in growth rate due to thyroxin supplementation could be explained on the view that the treatment increased T_4 level and this in turn increased the hepatic synthesis of RNA (Tata and Widnell, 1966) and accelerated the incorporation of amino acids into protein and hence protein synthesis (Moon, 1962 and Baccari *et al.*, 1983). The interaction between the season and dietary feed additives were insignificantly affected daily body gain weight (Table1).

3. Feed efficiency

Daily feed intake of rabbits decreased during summer than of those reared during winter with 10.74, 7.11 and 8.6%, respectively, at 0-4, 4-8 and 0-8 weeks of the experimental period (Table 2). These findings were similar to those obtained by Marai *et al.* (1994 a and b and 1999) and Ayyat and Marai (1997). Kasa *et al.* (1989) reported that the feed intake decreased by 12% at 30 °C than in those reared at 22°C. The most immediate impact of heat stress can be seen in changes of water and feed consumption. As the temperature rises, so does the animals need for water. However, rising temperatures also tend to reduce voluntary feed intake. This is the result of an attempt by the animal to reduce the production of body heat especially from fibrous feeds, lower physical activity (Roussel, 1992).

Daily feed intake decreased during summer than winter. Rabbits reared during summer season and fed diet without supplement recorded lower daily feed intake during 0-8 weeks of the experimental period than the other groups, where in winter supplemented feed additives reduced the value of feed intake.

Feed conversion was impaired with 12.28% in rabbits reared in summer season than those reared in winter at 0-4 weeks of the experimental period while at 0-8 weeks of the experimental period, feed conversion increased with 3.24% in summer than the winter season (Table 2). Ayyat and Marai (1997) reported that the rabbits reared in winter consumed less feed per unite gain than those reared during summer season. Feed conversion improved by using the feed additives during the whole experimental periods. Supplementation rabbit's diets with thyroxin (100 or 50 μg/kg diet) recorded the best feed conversion than the other feed additives. Feed conversion improved by using the feed additives during the whole experimental periods, within each year season (Table 2). Marai *et al.* (1994a) found that thyroxin injection 30 and 50 μg/kg body weight improved the feed conversion of heat stressed rabbits.

Table 2: Daily feed intake (g), feed conversion ratio (g food/g gain) and profit analysis of rabbits at different experimental periods as affected by season and some feed additives and their interaction.

Items	Daily Feed Intake			Feed Conversion Ratio			Profit Analysis				
	W0-4	W4-8	W0-8	W0-4	W0-4	W0-8	Feed intake (kg)	Body gain (kg)	Feed cost Rabbit	Return from Rabbit	Margin rabbit
Season:											
Winter	76.64	109.16	92.90	2.988	2.988	3.551	5.202	1.465	3.693	14.650	10.957
Summer	68.41	101.40	84.91	2.621	2.621	3.666	4.755	1.297	3.376	12.970	9.594
Feed additives:											
Without	72.40	105.56	88.98	2.239	2.239	4.059	4.983	1.228	3.538	12.280	8.742
T1	73.32	105.54	89.43	2.476	2.476	3.391	5.008	1.477	3.556	14.770	11.214
T2	74.02	106.01	90.02	3.259	3.259	3.328	5.041	1.347	3.579	13.470	9.891
M1	71.78	103.90	87.84	2.651	2.651	3.450	4.919	1.426	3.492	14.260	10.768
M2	70.57	104.30	87.44	2.597	2.597	3.597	4.897	1.361	3.477	13.610	10.133
L1	71.85	105.08	88.47	2.736	2.736	3.440	4.954	1.440	3.517	14.400	10.883
L2	73.75	106.58	90.17	2.814	2.814	3.633	5.050	1.390	3.586	13.900	10.314
Interaction between season and feed additives:											
Winter:											
Without	78.25	112.86	95.56	3.443	3.443	4.002	5.351	1.337	3.799	13.370	9.571
T1	77.13	110.03	93.58	2.675	2.675	3.363	5.240	1.558	3.720	15.580	11.860
T2	77.78	108.85	93.32	3.526	3.526	3.667	5.226	1.425	3.710	14.250	10.540
M1	75.25	106.95	91.10	2.830	2.830	3.380	5.102	1.509	3.622	15.090	11.468
M2	73.89	106.55	90.22	2.697	2.697	3.429	5.052	1.473	3.587	14.730	11.143
L1	76.55	108.25	92.40	2.785	2.785	3.434	5.174	1.507	3.674	15.070	11.396
L2	77.65	110.60	94.13	3.099	3.099	3.611	5.271	1.460	3.742	14.600	10.858
Summer:											
Without	66.54	98.25	82.40	3.030	3.030	4.130	4.614	1.117	3.276	11.170	7.894
T1	69.50	101.05	85.28	2.292	2.292	3.404	4.776	1.403	3.391	14.030	10.639
T2	70.25	103.16	86.71	2.998	2.998	3.855	4.856	1.259	3.448	12.590	9.142
M1	68.30	100.85	84.58	2.482	2.482	3.505	4.736	1.351	3.363	13.510	10.147
M2	67.25	102.05	84.65	2.495	2.495	3.795	4.740	1.249	3.365	12.490	9.125
L1	67.15	101.90	84.53	2.593	2.593	3.446	4.734	1.374	3.361	13.740	10.379
L2	69.85	102.55	86.20	2.553	2.553	3.657	4.827	1.320	3.427	13.200	9.773

T1 = Thyroxin 100 µg/kg diet, T2 = Thyroxin 50 µg/kg diet, M1 = Methionin 1.5 g/kg diet, M2 = Methionin 0.75 g/kg diet, L1 = Lysine 1.5 g/kg diet, L2 = Lysine 0.75 g/kg diet and W = experimental periods by weeks.

- Feed cost, Return from body gain and Margin/rabbit are calculated by Egyptian Lever (LE)

4- Profit analysis

Feed cost, return from body weight gain and final margin decreased with 8.58, 11.47 and 12.44%, respectively, in rabbits reared under summer conditions than those reared under winter conditions (Table 2). These results are similar to those reported by Ayyat and Marai (1997) and Marai *et al.* (1999). Feed cost slightly affected with feed additives, while return from body gain and final margin increased. Supplementation rabbit's diets with thyroxin (100 μg/kg diet), lysine (1.5 g/kg diet) and methionine (1.5 g/kg diet) recorded the higher final margin than the other rabbit groups. Within each season using the feed additives decreased the feed cost and increased the return from body gain and final margin. During the summer or the winter, supplemented rabbit diets with 100 μg thyroxin recorded higher return from body gain and final margin than the other feed additives.

5- Physiological parameters

Rectal temperature and respiration rate were increased significantly ($P<0.001$) in rabbits reared in summer when compared with those reared in winter (Table 3). The obtained results are in agreement with those obtained by Marai *et al.* (1994a and 1999). Higher respiration rate in rabbits reared in summer season as an important means to evacuate the latent heat in rabbits because their sweat glands are almost absent and perspiration is never great due to fur. Oliveira *et al.* (1985) reported that the rabbits were able to maintain constant rectal temperature during cold or heat exposure only when previously acclimated to these temperature extremes. Feed additive was insignificantly affected on rectal temperature and respiration rate. Interaction between year season and feed additives was insignificantly affected rectal temperature and respiration rate

6- Blood components

Serum total protein and its fractions: Serum total protein and albumin were significantly ($P<0.001$) decreased in heat-stressed rabbits than in those raised during winter, while serum globulin insignificantly decreased (Table 4). Serum total protein, albumin and globulin values decreased with 15.48, 22.71 and 3.48%, respectively, in rabbits reared during summer season when compared with those reared during winter season. The obtained results are in agreement with those obtained by Marai *et al.* (1994a and 1999) and Ayyat and Marai (1996). The significant decline in serum protein with rising temperature seems to be due to depression of anabolic hormonal secretion such as growth hormone (Yousef and Johnson, 1966), Generally, the plasma protein provides an efficient way of transferring the heat from inside the body to the outer surface of the skin for dissipation heat by non-evaporative processes during heat stress, since it holds adequate percentage of water in the intravascular fluids and maintains the viscosity of the blood (Kamal *et al.*, 1962). Serum total protein, albumin and globulin increased insignificantly by using the feed additives. Similar results were obtained by Prusiewicz *et al.* (1974) reported that the addition of DL-methionine in rabbit diets to level of 0.15% increased blood total protein by 18% than those received no methionine in their diets. Lebas and Colin (1973) and Colin (1975) reported that the improvement in growth rate as affected methionine supplementation in rabbit diets appears to result from better utilization and retention of nitrogen rather than from change in digestibility. Within each year season, the using of feed additives insignificantly increased the concentrations of serum total protein and albumin

Serum glucose, total lipids and cholesterol: Serum glucose, total lipids and

Table 3: Respiration rate and rectal temperature (°C) of rabbits at different experimental periods as affected by season and some feed additives and their interaction

Items	Respiration Rate		Rectal Temperature	
	W4	W8	W4	W8
Season:				
Winter	8 8.43±1.51	93.06±1.15	38.00±0.10	38.35±0.10
Summer	106.66±0.61	109.03±0.58	39.61±0.10	39.77±0.11
Significant	***	***	***	***
Feed additives:				
Without	96.50±5.00	99.90±4.32	38.78±0.33	39.10±0.38
T1	95.40±3.94	101.60±2.57	38.84±0.37	39.23±0.26
T2	96.50±3.87	101.30±2.53	38.81±0.37	39.11±0.28
M1	96.40±3.72	102.30±2.30	38.60±0.37	39.05±0.27
M2	101.90±1.94	100.50±3.39	38.89±0.30	39.05±0.29
L1	98.30±3.58	99.40±3.71	38.84±0.26	38.89±0.35
L2	97.80±3.26	102.30±2.91	38.89±0.30	39.02±0.32
Significant	NS	NS	NS	NS
Interaction between season and feed additives:				
Winter:				
Without	83.60±5.04	87.60±1.83	37.90±0.11	38.20±0.35
T1	84.40±2.79	94.60±1.72	37.94±0.36	38.62±0.20
T2	87.20±4.59	94.40±1.72	37.88±0.32	38.48±0.23
M1	87.60±4.58	96.60±2.60	37.80±0.42	38.42±0.17
M2	96.80±1.36	92.60±4.28	38.12±0.10	38.40±0.23
L1	90.20±4.65	90.00±4.04	38.28±0.21	38.04±0.28
L2	89.20±2.87	95.60±3.54	38.10±0.22	38.32±0.34
Summer:				
Without	109.40±2.01	112.20±2.22	39.66±0.28	40.00±0.34
T1	106.40±1.33	108.60±1.50	39.74±0.29	39.84±0.28
T2	105.80±1.77	108.20±1.43	39.74±0.28	39.74±0.31
M1	105.20±1.59	108.00±0.89	39.40±0.35	39.68±0.33
M2	107.00±1.45	108.40±1.50	39.66±0.32	39.70±0.35
L1	106.40±1.81	108.80±1.16	39.40±0.32	39.74±0.31
L2	106.40±1.63	109.00±1.76	39.68±0.23	39.72±0.34
Significant	NS	NS	NS	NS

T1 = Thyroxin 100 µg/kg diet, T2 = Thyroxin 50 µg/kg diet, M1 = Methionin 1.5 g/kg diet, M2 = Methionin 0.75 g/kg diet, L1 = Lysine 1.5 g/kg diet and L2 = Lysine 0.75 g/kg diet.
W = Experimental periods by weeks.
*** $P < 0.001$

Table 4: Blood components, serum urea-N and creatinine as kidney function and serum transaminase enzymes as liver function of rabbits as affected by season and some feed additives and their interaction

Items	Total protein	Albumin	Globulin	Glucose	Total lipids	Cholesterol	Urea-N	Creatinine	SGOT	SGPT
	g/dl			mg/dl			mg/dl		U/l	
Season:										
Winter	8.40±0.13	5.24±0.09	3.16±0.09	79.84±1.21	196.52±1.88	79.36±1.37	27.57±0.30	1.45±0.02	32.35±0.53	13.11±0.35
Summer	7.10±0.11	4.05±0.07	3.05±0.10	61.29±1.08	158.19±1.88	49.71±1.19	21.88±0.48	1.18±0.02	24.51±0.33	16.06±0.22
Significant	***	***	NS	***	***	***	***	***	***	***
Feed additives:										
Without	7.17±0.33	4.42±0.21	2.75±0.18	66.60±2.54	170.17±11.74	58.27±7.83	22.35±1.79	1.21±0.06	26.55±1.64	15.23±0.95
T1	7.98±0.37	4.70±0.32	3.28±0.16	72.83±4.37	182.83±9.73	66.33±6.50	25.13±1.36	1.37±0.06	29.42±2.26	14.48±0.84
T2	7.57±0.35	4.60±0.37	2.97±0.30	71.00±5.86	180.67±8.91	63.83±6.91	25.50±1.03	1.35±0.07	29.58±1.95	14.33±1.11
M1	8.03±0.34	4.67±0.33	3.37±0.04	72.33±5.16	176.33±9.68	63.67±7.60	24.42±1.37	1.32±0.08	29.40±2.02	14.80±0.66
M2	7.97±0.35	4.68±0.29	3.28±0.11	70.17±4.53	179.67±8.10	64.50±6.28	25.38±1.52	1.33±0.07	28.77±1.86	14.68±0.60
L1	7.87±0.38	4.90±0.35	2.97±0.13	70.50±5.16	175.33±7.83	65.50±6.66	25.00±1.47	1.33±0.07	27.83±1.69	14.47±0.85
L2	7.67±0.34	4.53±0.23	3.13±0.19	70.50±4.35	176.50±7.74	69.67±6.85	25.27±1.37	1.29±0.07	27.47±1.83	14.10±0.96
Significant	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
Interaction between season and feed additives:										
Winter:										
Without	7.80±0.32	4.83±0.15	2.97±0.19	71.53±1.92	195.00±7.64	75.20±4.01	25.77±1.05	1.32±0.06	29.80±1.27	13.60±0.90
T1	8.63±0.43	5.37±0.22	3.27±0.30	82.00±1.73	203.00±6.43	80.00±4.36	27.83±0.60	1.50±0.01	34.33±0.88	13.00±1.04
T2	8.13±0.29	5.33±0.30	2.80±0.32	83.33±4.26	200.00±2.65	78.67±2.03	27.33±1.20	1.48±0.02	33.67±0.88	12.33±1.45
M1	8.70±0.26	5.33±0.26	3.37±0.03	83.00±2.31	196.33±4.67	79.67±4.91	27.17±0.60	1.47±0.04	33.67±1.20	13.50±0.29
M2	8.60±0.36	5.27±0.26	3.33±0.15	78.67±3.18	196.67±5.78	77.67±4.48	28.43±0.32	1.46±0.04	32.67±1.20	13.67±0.44
L1	8.57±0.41	5.57±0.23	3.00±0.25	81.00±2.89	192.00±4.73	80.00±2.65	28.17±0.60	1.47±0.04	31.33±0.88	13.00±1.15
L2	8.37±0.29	4.97±0.12	3.40±0.30	79.33±2.03	192.67±4.10	84.33±4.18	28.27±0.38	1.43±0.03	31.00±2.08	12.67±1.45
Summer:										
Without	6.53±0.19	4.00±0.15	2.53±0.29	61.67±2.03	145.33±3.71	41.33±1.86	18.93±1.82	1.10±0.02	23.30±1.14	16.87±1.04
T1	7.33±0.26	4.03±0.18	3.30±0.21	63.67±2.91	162.67±5.04	52.67±2.33	22.43±1.27	1.23±0.04	24.50±0.76	15.97±0.47
T2	7.00±0.47	3.87±0.20	3.13±0.55	58.67±1.20	161.33±4.06	49.00±3.79	23.67±0.73	1.21±0.08	25.50±1.26	16.33±0.26
M1	7.37±0.23	4.00±0.15	3.37±0.09	61.67±3.76	156.33±6.84	47.67±2.91	21.67±1.20	1.17±0.07	25.13±0.88	16.10±0.61
M2	7.33±0.30	4.10±0.12	3.23±0.19	61.67±4.48	162.67±2.33	51.33±1.86	22.33±1.45	1.20±0.08	24.87±0.86	15.70±0.74
L1	7.17±0.24	4.23±0.35	2.93±0.12	60.00±3.79	158.67±2.60	51.00±2.08	21.83±0.60	1.18±0.05	24.33±1.09	15.93±0.35
L2	6.97±0.12	4.10±0.25	2.87±0.13	61.67±3.53	160.33±4.67	55.00±1.53	22.27±0.43	1.15±0.08	23.93±0.03	15.53±0.67
Significant	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

T1 = Thyroxin 100 µg/kg diet, T2 = Thyroxin 50 µg/kg diet, M1 = Methionin 1.5 g/kg diet, M2 = Methionin 0.75 g/kg diet, L1 = Lysine 1.5 g/kg diet and L2 = Lysine 0.75 g/kg diet.
NS = non significant * = $P<0.05$ *** = $P < 0.001$

cholesterol were significantly ($P<0.001$) affected with year season (Table4). Serum glucose, total lipids and cholesterol decreased in rabbit groups reared during summer season with 23.23, 18.50 and 37.36%, respectively, when compared with those reared during winter season. The concentrations of serum glucose, total lipids and cholesterol insignificantly increased as supplemented rabbit diets with feed additives. On the other hand, Palluden (1972) and Godden *et al.* (1973) showed that the increase in quantities of T_4 decreased the level of circulating lipids in the blood and increased cholesterol degradation in the liver. The concentrations of serum glucose, total lipids and cholesterol insignificantly affected with the interaction between year season and feed additives. Within each feed additives group, rabbits reared during summer season recorded lower serum glucose, total lipids and cholesterol concentrations than those reared during winter.

Serum urea-N and createinine significantly ($P<0.001$) decreased with 20.64 and 18.62%, respectively, in heat-stressed rabbits than in those raised during winter (Table4). The obtained results are in agreement with those obtained by Marai *et al.* (1994a and 1999). Serum urea-N significantly ($P<0.05$) affected with feed additives, while serum createinine insignificantly affected. Concentrations of serum urea-N and createinine increased in rabbits fed diets supplemented with feed additives. Within each year season, supplemented the feed additives in rabbit's diet insignificantly increased the level of serum urea-N and createinine.

Serum transaminases (SGOT & SGPT) significantly ($P<0.001$) affected with year season. SGOT decreased with 24.23% in heat-stressed rabbits than in those raised during winter, while SGPT increased with 22.50% (Table4). The obtained results are in agreement with those obtained by Marai *et al.* (1994a and 1999). The concentrations of SGOT and SGPT insignificantly affected with supplementation the feed additives in rabbit's diet. Using the feed additives in rabbit diets increased the concentration of SGOT and decreased SGPT. The concentration of SGOT and SGPT insignificantly affected with the interaction between year season and feed additives. Within each year season, supplemented the feed additives in rabbit's diet insignificantly increased the level of serum SGOT.

7- Carcass and non-carcass components

Analysis of covariance cleared that the linear regression on pre-slaughter live body weight were significantly affected carcass weight, liver weight, kidney weigh, kidney fat weight and carcass cuts (Table5). Analysis of variance indicated that the season affected significantly ($P<0.01$) pre-slaughter body weight. However, analysis of covariance indicated that adjusted carcass weight, kidney fat weight and the fore part of carcass were significantly affected with year season. Dressing percentage increased in rabbits reared in winter than those reared in summer. Analysis of variance indicated that the dietary feed additives insignificantly affected pre-slaughter live body weight. Also, analysis of covariance did not show any significant effects on carcass and non carcass components. Dressing percentage slightly increased in rabbits fed diet supplemented with thyroxin, methionine and lysine.

Carcass weights were 708.13, 791.67, 806.67 and 743.89 g, respectively, in rabbits fed diets supplemented with 0.2, 0.4, 0.6 or 0.8% methionine (Pinto and Carregal, 1994). On the other hand, Scapinello *et al.* (1995a and b) reported no effect of lysine on performance or carcass characteristics.

Table 5: Dressing percentage, actual pre-slaughter live body weight and adjusted carcass and non-carcass components weight (g) of rabbits as affected by season and some feed additives and their interaction

Items	Slaughter live Weight	Carcass Weight	Liver Weight	Kidney Weight	Kidney fat weight	Dressing percentage
Season:						
Winter	2097.14±41.65	1253.27±3.00	62.46±1.44	16.38±0.37	15.93±0.57	61.55
Summer	1971.43±21.61	1234.35±3.00	61.68±1.44	16.52±0.37	13.59±0.57	60.73
Significant	**	***	NS	NS	**	
Feed additives:						
Without	1959.17±59.56	1240.58±5.42	62.87±2.60	16.34±0.67	15.82±1.04	61.03
T1	2106.67±64.23	1252.72±5.41	56.16±2.60	15.17±0.66	12.21±1.03	61.50
T2	2023.33±44.92	1241.52±5.29	60.15±2.54	15.55±0.65	14.29±1.01	61.05
M1	2092.50±59.24	1245.32±5.37	68.03±2.58	16.40±0.66	14.87±1.03	61.16
M2	3030.00±68.54	1250.05±5.29	64.23±2.54	16.35±0.65	14.88±1.01	61.44
L1	2084.17±58.24	1234.46±5.35	62.31±2.57	17.61±0.66	15.46±1.02	60.68
L2	1944.17±74.85	1242.01±5.48	60.75±2.63	17.74±0.67	15.82±1.05	61.11
Significant	NS	NS	NS	NS	NS	
Interaction between season and feed additives:						
Winter:						
Without	2058.33±66.85	1249.01±7.49	61.33±3.60	14.89±0.92	18.40±1.43	61.38
T1	2178.33±111.52	1260.87±7.82	51.34±3.75	13.68±0.96	12.76±1.49	61.80
T2	2080.00±61.10	1246.10±7.52	57.70±3.61	16.79±0.92	15.83±1.44	61.23
M1	2135.00±191.85	1258.34±7.65	75.27±3.67	16.55±0.94	17.57±1.46	61.75
M2	2168.33±46.93	1263.49±7.78	69.81±3.73	17.06±0.95	15.21±1.49	61.97
L1	2146.67±102.89	1239.73±7.69	63.44±3.69	18.49±0.94	16.77±1.47	60.91
L2	1913.33±160.01	1255.38±7.72	58.34±3.71	17.21±0.95	14.99±1.48	61.79
Summer:						
Without	1860.00±58.59	1237.15±7.97	64.41±3.82	17.79±0.98	13.23±1.52	60.68
T1	2035.00±55.30	1244.57±7.48	60.99±3.59	16.66±0.92	11.66±1.43	61.19
T2	1966.67±56.08	1236.94±7.56	62.60±3.63	14.30±0.93	12.74±1.44	60.86
M1	2050.00±34.64	1232.31±7.49	60.78±3.59	16.26±0.92	12.16±1.43	60.57
M2	1891.67±46.40	1236.62±7.81	58.64±3.75	15.64±0.96	14.56±1.49	60.91
L1	2021.67±49.69	1229.18±7.49	61.17±3.59	16.72±0.92	14.14±1.43	60.45
L2	1975.00±38.19	1228.65±7.54	63.15±3.62	18.27±0.93	16.65±1.44	60.43
Significant	NS	NS	*	*	NS	

T1 = Thyroxin 100 µg/kg diet, T2 = Thyroxin 50 µg/kg diet, M1 = Methionin 1.5 g/kg diet, M2 = Methionin 0.75 g/kg diet, L1 = Lysine 1.5 g/kg diet and L2 = Lysine 0.75 g/kg diet.
NS = non significant * = P< 0.05 ** = P< 0.01 ***= P< 0.001

Analysis of variance indicated that the dietary feed additives insignificantly affected pre-slaughter live body weight. Also, analysis of covariance did not show any significant effects on carcass weight and carcass cuts weight and kidney fat weight.

REFERENECES

Ayyat,M.S. (1991). Growth and carcass production of growing rabbits as affected by dietary energy level. Zagazig Journal of Agriculture Research, 18 (1): 109-122.

Ayyat,M.S. and I.F.M.Marai (1997). Effects of heat stress on growth, carcass traits and blood components of New Zealand White rabbits fed various dietary energy-fibre, under Egyptian conditions. Journal of Arid Environments, 37: 557-568.

Ayyat,M.S.;H.A.Gabr;I.F.M. Marai and U.M. Abdel-Monem (1997). Alleviation of heat-stressed growing rabbits by suing some chemical growth enhances under subtropical Egyptian conditions. Proceeding of the International Conference on Animal, Poultry and Rabbit Production and Health, Cairo, Egypt, pp. 637-651.

Ayyat,M.S. and I.F.M.Marai (1996). Effects of summer heat stress on growth performance, some carcass traits and blood components of New Zealand White rabbits fed different dietary protein-energy levels, under sub tropical Egyptian conditions. 6th World Rabbit Congress, Toulouse Vol2: 151-161.

Baccari F.J., Johnson H.D. and Hahn G.L. (1983). Environmental heat effects on growth. Exp. Biol. Med., 173: 312.

Colin,M. (1975). Effects of supplements of L-lysine and DL-methionine to simplified plant rations on growth of rabbits. Annales de Zootechine, 24:465-473.

Coventry,J. and A. Phillips (2000). HEAT STRESS IN CATTLE. Business, Industry And Resource Development, No. 788 J75, October 2000, Northern Territory Of Australia.

Daader,A.H.;I.F.M.Marai;A.A.Habeeb and H.M.Yousef (1989). Improvement of growth performance of Friesian calves under Egyptian subtropical conditions. I. internal cooling technique using diuretics and drinking cool water. Proceeding of 3rd Egyptian-British Conference on Animal, Fish and Poultry Production, Alexandria, Egypt, Vol. 2: 595-605.

Godden, J.D.;C.Eyrin;R.Volpe and R.Wilson (1973). The Thyroid Gland. In Systematic Endocrinology. Edited by Harpen S.M., Saunders Company, Philadelphia, London. pp 5-124.

González,L.G. (1975). Cunicultura tropical. La Habana, Instituto Cubano del Libro. pp. 338.

Habeeb,A.A.; I.F.M.Marai and T.H.Kamal (1992). European breeds arid zone climate, chapter, heat stress in farm animals and environment. Edited by Phillips C. and Pagnes D., International U.K., pp. 27-47.

Habeeb, A.A.;I.F.M.Marai.;Gh.A.El-Sayiad and M.Z.Nessem (1994). Effect of internal and external cooling techniques on growth and physiological functions of New Zealand White and Californian rabbits maintained under hot summer conditions of Egypt. Options Mediterraneennes, 8 (Supplement): 626-633.

Kamal,T.H.;H.D.Johanson and R.C.Ragsbale (1962). Metabolic reactions during thremal stress (35 to 95 °F) in dairy animals acclimated at 50 and 80 °F. Mo. Agriculture Station Research, Bull. 785.

Kasa, W.;C.J.Thwaites; X.Jianke and D.J.Farrell (1989). Rice bran in the diet of rabbits grown at 22 °C and 30

°C. Journal of Applied Rabbit Research, 12: 75-77.

Lebas,F. (1983). Small-scale rabbit production - feeding and management systems. World Anim. Rev.,46:11-17.

Lebase,F.and M.Colin (1973). Protein requirement of the growing rabbit. Proceeding of the International Conference on Rabbit Production, Italy, 266-274.

LPHSI (1990). Livestock and Poultry Heat Stress Indices, Agriculture Engineering Technology Guide, Clemson University, Sc 29634, USA.

Marai,I.F.M. (1997). Increasing lean meat production. International Conference on Animal Production and Health, 185-195.

Marai,I.F.M.;M.S.Ayyat;H.A.Gabr and M.Abdel-Monem (1999). Growth performance, some blood metabolites and carcass traits of New Zealand White broiler male rabbits as affected by heat stress and its alleviation, under Egyptian conditions. Cahiers-Options-Mediterraneennes, 41: 35-42.

Marai,I.F.M.andA.A.Habeeb (1994). Thermoregulation in rabbits.Options Mediteran- eennes, 8: 33-41.

Marai,I.F.M.; K.A.El-Masry and A.S.Nasr (1994a). Heat stress and its amelioration with nutrtional, buffering, hormonal and physical techniques for New Zealand White rabbits maintained under hot summer conditions of Egypt. Cahiers Options Mediterraneennes, 8 (Supplement): 475-487.

Marai,I.F.M.;A.A.M.Habeeb;Gh.A.El-Sayiad and M.Z.Nessem (1994b).Growth performance and physiological response of New Zealand White and Californian rabbits under hot summer conditions of Egypt. Cahiers Options Mediterraneennes, 8 (Supplement): 619:625.

Moon, R.C. (1962). Influence of thyroxin function upon pituitary lactogenic hormone content. Fed. Proc., 21: 193.

Niles, M.A.; R.J.Collien and W.J.Croom (1980). Effect of heat stress on rumen and plasma metabolite and plasma hormone concentration of Holestein cows. Journal of Animal Science, 51: 152 (Abstract).

National Research Council (NRC) (1977). Nuttrient Requirements of Rabbits. 2nd Ed., Nat. Aced.Sci. Washington D.C., USA.

Oliveira,S.G.; J.Tarasantchi and M.A. Griggio (1985). Effects of temperature acclimation on rabbit metabolic rate and rectal Temperature. Brazilian J. Med. Biol. Res., 18 (3): 367-372.

Omole,T.A. and O.L.Oke (1980). The use of leaf protein concentrate as rabbit feed. Nutrition Reports International, 21 (4): 587-593.

Palluden, B. (1972). Studies of the thyroxin function in pigs. Proceeding of a Symposium of Isotope Studies on the Physiology of Domestic Animals, Organized by the IAEA and FAO, Athens, p. 199.

Pinto,H.F. and R.D.Carregal (1994). Effect of methionine feed supplements during the growing period in Selecta rabbits. Revista da Sociedade Brasileira de Zootecnia, 23 (5): 813-822.

PrudHon,M. (1976). Comportment Alimentaire du Lapin Soumis à des température de 10°.20° et 30° C.Proc. 1ère congr.Mond. cuniculture. Dijon, France. Communication n° 14.

Prusiewicz,U.W.;J.Chichlowska and H.Wargch, (1974). Effects of supplements of lysine and methionine to the basal diet on some blood values and weight gains of rabbits. Polsika Archiwum Veterynyane, 17: 149-158.

Roussel,J.D. (1992). Heat Stress. Goat Handbook.The National Dairy Database. Hutchinson; Pennsylvania State

U., University Park. Louisiana State U., Baton Rouge.

Ruff,C.B. (1994). Morphological adaptation to climate in modern and fossil hominoids. Yearbook of Physical Anthropology 37:65-107.

Scapinello, C.; M.L. Tafuri; H.S. Rostagno;A.C .Furlan and I.Moreira (1995a). Methionine plus cystine requirement of growing New Zealand White rabbits. Revista da Sociedade Brasileira de Zootecnia, 24 (6): 981-991.

Scapinenello, C.;M.L. Tafuri; H.S. Rostagno;A.J. Regazzi;A.C. Furlan and E.N. Martins (1995 b). Lysine requirement of growing New Zealand White rabbits. Revista da Sociedade Brasileira de Zootecnia, 24 (6): 972-980.

Snedecor,G.W. and W.G.Cochran (1982). Statistical Methods. 6th Edition. Iowa State University Press, Ames, USA.

Spreadbury,D. (1978). A study of the protein and amino acids requirements of the growing New Zealand White rabbits with emphasis on lysine and the sulphur containing amino acids. British J. Nutrition, 39:601-611.

Tata,J.R. and C.C.Widnell (1966). Ribonucleic acid synthesis during the early action of thyroid hormone. Biochemistry Journal, 98: 604.

Yousef,M.K. and H.D.Johnson (1966). Calorigensis of dairy cattle as influenced by thyroxine and environmental temperature. J. Anim. Sci., 25: 150-156.

تخفيف العبء الحراري في الأرانب النامية باستخدام بعض الإضافات الغذائية تحت الظروف المصرية

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أجريت هذه الدراسة بمزرعة الأرانب بقسم الإنتاج الحيوانى – كلية الزراعة – جامعة الزقازيق، فى شهر ديسمبر ٢٠٠٠ إلى شهر يناير ٢٠٠١ (وهى تمثل موسم الشتاء) ومن شهر يوليو إلى أغسطس من عام ٢٠٠١ (وهى تمثل موسم الصيف). وقد استخدم ١٤٠ أرنب نيوزيلاندى أبيض – عمر الفطام (٣٥ يوم) ذات أوزان متقاربة عند بداية التجربة – تم تقسيمها إلى ١٤ مجموعة فى كل منها ١٠ أرانب. السبع مجاميع الأولى تم تربيتها فى موسم الشتاء فى حين المجاميع الأخرى تم تربيتها فى موسم الصيف. فى داخل كل موسم، المجموعة الأولى تم تغذيتها على عليقة المقارنة بدون أى إضافة والثانية تغذت على عليقة أضيف أليها ١٠٠ ميكروجرام ثيروكسين، فى حين تغذت المجموعة الثالثة على عليقة أضيف أليها ٥٠ ميكروجرام ثيروكسين، والمجموعة الرابعة تغذت على عليقة أضيف أليها ١,٥ جرام ميثيونين، والمجموعة الخامسة تغذت على عليقة أضيف أليها ٠,٧٥ جرام ميثيونين، والمجموعة السادسة تغذت على عليقة أضيف أليها ١,٥ جرام لايسين، والمجموعة السابعة تغذت على عليقة أضيف أليها ٠,٧٥ جرام لايسين / كجم عليقة . وأكدت الدراسة أن تعرض الأرانب للإجهاد الحراري يخفض معدل النمو والكفاءة الغذائية وان إضافة المثيونين واللايسين والثيروكسين الى علائق الأرانب المجهدة حراريا يحسن من أداء الأرانب.