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

Marai I.F.M., Ayyat M.S., Gabr H.A., Abdel-Monem U.M.

in

Testik A. (ed.), Baselga M. (ed.).
2. International Conference on Rabbit Production in Hot Climates

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 41

1999
pages 35-42

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

I.F.M. Marai, M.S. Ayyat, H.A. Gabr and U.M. Abdel-Monem
Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt.

SUMMARY - In summer, most of growth performance traits studied of the New Zealand White (NZW) broiler male rabbits were inversely affected. Final live body weight, body gain weight, daily feed intake, feed cost, return from body gain and final margin, weights of carcass, fore part, intermediate part, hind part, head, kidney and kidney fat, as well as, blood total protein, albumin, globulin, albumin-globulin ratio and total lipids, were lower in summer than in winter. Supplementation of heat-stressed rabbits with palm oil (10% of the diet) improved final live body weight, body gain weight, feed conversion, final margin, albumin-globulin ratio and weights of carcass fore part, intermediate part, hind part and kidney. On the other hand, feed intake, feed cost, water intake, respiration rate, rectal temperature, plasma total protein, albumin, globulin, total lipids, cholesterol decreased. Tafla (which is a natural clay) addition (5% of the diet) to heat-stressed rabbit diets increased final live body weight, body gain weight, feed conversion, return from body gain, final margin and weights of carcass, fore part, intermediate part and hind part and decreased feed intake, water intake, respiration rate, rectal temperature, blood total protein, albumin, globulin and cortisol. Treatment of heat-stressed rabbits by drinking cool water (10-15 °C) increased final live body weight, gain weight, feed intake, feed conversion and final margin and decreased water intake, respiration rate, rectal temperature, plasma total protein, albumin and albumin-globulin ratio. Drinking cool water showed the highest body weight, total body gain and margin percentage.

Key words: Heat stress, alleviation, productive performance, blood metabolites, carcass.

INTRODUCTION

In Egypt, the climate is characterized by a long hot period (from May to October) and short mild one (from December to March). In hot period, rabbits have difficulty in elimination body heat due to their unfunctional sweat glands (Marai *et al.*, 1991, 1994a,b and 1996). Modification of the hot environment, reducing the animal's heat production and increasing its heat loss, help in keeping the animal within the range of its thermoneutral state that realizes comfort. Alleviation of heat-stressed animals can be carried out by either chemical (Ayyat *et al.*, 1997), physical (Habeeb *et al.*, 1994 and Marai *et al.*, 1994a) or nutritional techniques (Marai *et al.*, 1994a).

In the present study, it was aimed to investigate the effects of hot climate of Egypt and its alleviation using palm oil (10% of the diet), tafla as natural clay (5% of the diet) and drinking cool water (10-15°C) on growth performance, some blood metabolites and carcass traits of New Zealand White broiler male rabbits.

MATERIALS AND METHODS

The practical work was carried out in the Rabbitry of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, during the period from November to March (mild weather) and from June to October (hot climate).

Animals

A total of 60 of New Zealand White (NZW) weaned male rabbits of 35 days of age and 796.3 g average body weight, were randomly allotted to 5 groups of nearly equal average weight with 12 animals in each. One group was raised during winter and the other groups were raised during summer. One of the latter groups was kept without any treatment as control and each of the other groups was supplemented with either 10%

palm oil of the diet, 5% tafla (which is a natural clay; Table 1) of the diet or drinking cool water (10-15 °C) for alleviation the heat stress. The experimental period was seven weeks; i.e. until marketing age.

Feeding and management

The animals were fed on pelleted diet and watered *ad libtum*. Each kilogram of the basal diet consisted of 300 g alfalfa hay, 240 g corn, 130 g soybean meal, 280 g wheat bran, 30 g molasses, 14 g limestone, 3 g chloride salt and 3 g vitamins and mineral premix. The basal diet contained 16.3% crude protein, 13.2% crude fibre (both were analyzed according to AOAC, 1980) and 2668 kcal digestible energy (calculated according to NRC, 1977). All rabbits were kept under similar managerial and hygienic conditions, during the experimental period. The rabbits were housed in cages provided with feeders and automatic nipple drinkers. The building was naturally ventilated and provided with sided electric fans. The ambient temperatures and relative humidity values were 14.98 °C and 60.0%, during the mild weather and 29.74 °C and 84.0%, respectively, during the hot climate period.

Traits measured

The rabbits were individually weighed at beginning of the experiment, then at weekly intervals. Weighing was carried out before offering the morning meal (once a week) at 8.00 h and live body gain weight was calculated weekly, but averages of body weights at 0, 3 and 7 weeks and body gain weights between 0-3, 3-7 and 0-7 weeks of the experimental period, were studied. Respiration rate and rectal temperature were recorded once a week at 9.00-11.00 h for each animal. The respiration rate was recorded by counting the flank movements per minute by using a hand counter. The rectal temperature was measured by using a clinical thermometer inserted into the rectum for 2 minutes at depth of 2 cm. At the end of the experimental period, 4 male rabbits from each group were randomly taken for slaughter. After complete bleeding, pelt, visceras and tail were removed and the carcass and some carcass components were weighed, and carcass component percentages were calculated from actual means. Blood samples of males were collected during slaughter by using tubes containing anticoagulant to obtain plasma. Plasma total protein, albumin, total lipids, cholesterol and cortisol were determined by using commercial kits.

Calculations

Economic evaluation was calculated as the following equation, Margin = Return from body gain - Feed cost. Other head costs were assumed constant. Price of one kg diets was 0.53 L.E (Egyptian pound = 0.3 $) and price of selling one kg live body weight of rabbits was 6.0 L.E. The temperature-humidity index (THI) was calculated according to Livestock and Poultry Heat Stress Indices, Agriculture Engineering Technology Guide, Clemson University, Clemson, Sc 29634, USA, using the following formula: THI = db°F – (0.55 - 0.55 RH)(db°F-58), where db°F = dry bulb temperature in Fahrenheit and RH = relative humidity percent / 100. The obtained values were classified as followed: <82 = absence of heat stress, 82-<84 = moderate heat stress, 84-<86 = severe heat stress and over 86 = very severe heat stress.

Statistical analysis

The data of body weight, body gain weight, rectum temperature, respiration rate and blood components were analyzed by completely random design, according to Snedecor and Cochran (1982) using the following model: $X_{ij} = \mu + T_i + e_{ij}$ (Model 1), where μ = general mean, t_i = effect of treatment and e_{ij} = random error. Significant differences were determined by Duncan's Multiple Range Test (Duncan, 1955). Slaughter data were analyzed by covariance according the following model: $X_{ij} = \mu + T_i + b(X-x) + e_{ij}$ (Model 2), where μ, t_i and e_{ij} were as defined in Model 1, b= partial liner regression coefficients of X_{ij} on slaughter weight, X= value of slaughter weight and x= overall average of slaughter weight.

RESULTS AND DISCUSSION

Temperature humidity index

Temperature humidity index values were 58.9 and 84.3 during the mild and hot climate periods of the year, respectively, indicating absence of heat stress during the mild climate and exposure of the animals to severe heat stress during the hot climate, in the present study.

Effect of heat stress

In summer, most of growth performance traits studied of the NZW broiler male rabbits were inversely affected (Tables 2-5 and Fig. 1).Comparison with winter showed that the decline values were 14.1% (P<0.01) in final live body weight, 21.4% (P<0.1) in body gain weight (0-7 weeks), 2.9% in daily feed intake, 3.1% in feed cost, 21.4% in return from body gain and 31.5% in the final margin (Fig. 1). Weights of carcass, fore part, intermediate part, hind part, head, kidney and kidney fat, as well as, blood total protein, albumin, globulin, albumin-globulin ratio and total lipids were also lower in summer than in winter. The traits which were higher in summer than in winter were feed consumed to produce one kilogram gain (23.6%), water intake (157.8%), respiration rate at 7 weeks (4.33%), rectum temperature at 7 weeks (0.86%; P<0.05), as well as, serum cholesterol and cortisol (122.95%; P<0.05).

The decrease in each of the growth performance and profit analysis traits during summer was mainly due to the decline in dry matter intake as a result to stimulation of the thermal receptors by the high environmental temperature to transmit suppressive nerve impulses to the appetite centre in the hypothalamus, that was reflected as fewer available substrates for hormone synthesis and heat production. In addition, exposure to severe heat stress suppresses the production of hormone releasing factors from the hypothalamic centre causing a decrease in pituitary hormonal secretion. Shortage of each of energy and protein substrates and hormones, affected inversely the capacity of protein synthesis and blood compounds and accordingly body gain weight. Particularly, the increase in serum cortisol concentration during heat stress exposure inhibits protein synthesis in tissues and may promote protein and lipid catabolism. Haemodilution as a result of the increase in water consumption may be another reason of the decrease in concentration of blood components (Marai *et al.*, 1994a,b and 1996).

The increase in respiration rate enables the animals to dissipate excess body heat by vaporizing more moisture in the inspired air. The increase in rectal temperature may be due to failure of the physiological mechanisms to maintain the thermal balance of the animals (Marai *et al.*, 1994a,b and 1996).

Alleviation of heat stress

Treatment of the heat-stressed NZW broiler rabbits with palm oil, tafla and drinking cool water improved all the affected traits (Tables 2-5 and Fig. 2).

Treatment with palm oil (10% of the diet)

Traits that increased with palm oil treatment were final live body weight (5.57%), body gain weight at 0-7 weeks (8.94%; P<0.05), feed conversion (38.3%), final margin (17.0%), albumin-globulin ratio (5.98%) and weights of fore part (1.3%), intermediate part (1.2%), hind part (1.2%) and kidney (3.5%), and those decreased were feed intake (32.8%), feed cost (1.21%), water intake (30.9%), respiration rate (3.63), rectal temperature (0.43%), plasma total protein (5.2%), plasma albumin (2.6%), plasma globulin (8.3%; P<0.05), plasma total lipids (4.4%), plasma cholesterol (10.8%; P<0.05) and weights of carcass (0.4%), empty gut (5.1%), liver (27.2%) and kidney fat (28.4%) (Tables 2-5 and Fig. 2). Ayyat (1991) and Marai *et al.* (1994a) reported similar results. The increase observed in the traits with palm oil supplementation may be attributed to the low wasted heat due to the specific dynamic action of palm oil digestion in comparison with that of the digestion of each of the components of the other diets. The decrease in water intake with palm oil supplementation may be due to the decrease in dry matter intake. Depression in plasma cholesterol with palm oil may be attributed to direct effects of some fatty acids, i.e. oleic and linoleic acids as mono- and ploy-unsaturated fatty acids, respectively, on cholesterol biosynthesis (PORIM, 1987).

Treatment with tafla (5% of the diet)

With regard to tafla treatment, the results that increased were final live body weight (5.8%), body gain weight at 0-7 weeks (8.16%; P<0.05), feed conversion (18.2%), return from body gain (8.3%), final margin (23.6%) and weights of carcass (3.1%), fore part (4.2%), intermediate part (8.1%) and hind part (5.1%) and those decreased were feed intake (11.6%), water intake (27.5%), respiration rate (0.11%; P<0.05), rectal temperature (0.67%; P<0.05), blood total protein (12.9%), albumin (13.6%), globulin (12.1%), cortisol (50.9%; P<0.05), empty gut weight (20.7%), liver weight (24.9%) and kidney fat weight (3.3%) (Tables 2-5 and Fig. 2). Improvement of body gain weight by addition of tafla clay may be due to its role in decreasing rate of food

Table 1. Tafla microelements.

Items	Means	Items	Means
Soluble cations and anions (meq/100 g soil):		Exchangeable cations (meq/100 g soil)	2.65
Ca^{++}	0.75	Available nutrients (mg/100 g soil):	
Mg^{++}	0.25	P	5.00
Na^{+}	0.05	K	1.20
K^{+}	0.10	Fe	0.55
Cl^{-}	0.55	Mn	2.40
So_4	0.30	Zn	0.74
HCO_3	0.75	Cu	0.30

Tables 2. Growth performance, feed intake, feed conversion and profit analysis of NZW broiler male rabbits as affected by severe heat stress and its alleviation.

Items	Winter	Summer Control	Summer Palm oil	Summer Tafla	Summer cool water	Sig
Body weight (g):						
W0 (At weaning)	799.6±39.27 a	774.4±49.30 a	786.3±41.62 a	797.5±31.83 a	798.8±37.87 a	NS
W3	1287.1±45.73 a	1161.7±54.38 a	1289.4±62.68 a	1283.8±55.78 a	1296.7±46.81 a	NS
W7	1998.8±44.83 a	1716.8±66.81 b	1812.5±81.8 b	1816.9±70.61 b	1901.7±45.04 ab	*
Body gain (g):						
W0-W3	23.21±1.23 a	18.44±0.69 b	23.96±1.77 a	23.15±2.20 a	23.71±1.26 a	+
W3-W7	25.42±1.26 a	19.82±0.80 b	18.68±1.40 b	19.04±1.17 b	21.61±0.80 b	***
W0-W7	24.47±0.79 a	19.23±0.52 c	20.95±1.80 bc	20.80±1.32 bc	22.51±0.78 ab	**
Feed performance:						
Feed intake (g/day)	98.00	95.20	64.00	84.20	96.30	
Feed conversion (kg feed/kg gain)	4.005	4.951	3.055	4.048	4.278	
Profit analysis (LE/head):						
Feed cost	2.55	2.47	2.44	2.19	2.58	
Return from body gain	7.19	5.65	6.16	6.12	6.62	
Margin	4.64	3.18	3.72	3.93	4.12	
Margin (%)*	100.0	68.53	80.17	84.70	88.79	

Means bearing different letters within the same classification, differ significantly (P<0.05).
W = Week, Sig = significance * When considering the winter group as 100%.
*** P<0.001, ** P<0.01, * P<0.05 and + P<0.1.

Table 3. Water intake (Millilitres) as affected by severe heat stress and its alleviation, during the last 5 weeks of the experimental period.

Groups	W1	W2	W3	W4	W5	Means
Winter	150.3	175.6	246.0	249.6	322.4	228.8
Summer	625.0	573.3	597.0	582.8	572.0	589.8
Palm oil	444.0	355.6	446.8	413.2	378.0	407.8
Tafla	422.5	351.0	479.3	446.0	440.0	427.8
Cool water	354.7	310.0	288.3	405.0	393.0	350.2

W = Week of the experimental period.

Table 4. Rectum temperature, respiration rate and blood composition of NZW broiler male rabbits.

Items	Winter	Summer Control	Summer Palm oil	Summer Tafla	Summer Cool water	Sig
Rectum temperature (°C):						
W1	38.63±0.07^{c}	40.14±0.04^{a}	39.96±0.07^{ab}	39.56±0.03^{b}	39.80±0.03^{ab}	***
W3	39.70±0.03^{b}	40.04±0.04^{a}	39.79±0.04^{ab}	39.71±0.03^{b}	39.65±0.03^{b}	+
W7	39.64±0.02^{b}	39.98±0.02^{a}	39.81±0.04^{ab}	39.71±0.03^{b}	39.71±0.03^{b}	*
Respiration rate:						
W1	106.00±0.88^{ab}	109.63±1.31^{a}	99.00±1.04^{b}	99.13±0.81^{b}	106.20±0.69^{ab}	*
W3	103.50±0.96^{ab}	112.25±1.41^{a}	102.25±0.94^{b}	100.63±0.95^{b}	103.60±0.94^{ab}	*
W7	112.75±0.93^{ab}	117.63±0.32^{a}	113.36±1.17^{ab}	117.50±0.77^{a}	111.60±0.39^{b}	*
Blood constituents:						
Total protein (g/dl)	6.53±0.15^{a}	5.75±0.10^{b}	5.45±0.18^{b}	5.01±0.05^{c}	5.41±0.15^{bc}	+
Albumin (g/dl)	3.53±0.20^{a}	3.10±0.08^{b}	3.02±0.11^{bc}	2.68±0.04^{c}	2.77±0.11^{bc}	+
Globulin (g/dl)	3.00±0.06^{a}	2.65±0.03^{b}	2.43±0.07^{c}	2.33±0.07^{c}	2.64±0.04^{b}	+
Albumin / Globulin	1.18±0.09^{ab}	1.17±0.02^{ab}	1.24±0.01^{a}	1.15±0.05^{ab}	1.05±0.03^{b}	*
Total lipids (mg/dl)	3.44±0.18^{a}	3.39±0.04^{a}	3.24±0.06^{a}	3.49±0.10^{a}	3.22±0.03^{a}	+
Cholesterol (mg/dl)	1.17±0.03^{ab}	1.20±0.06^{a}	1.07±0.03^{bc}	1.20±0.01^{a}	1.00±0.01^{c}	*
Cortisol (mg/dl)	8.67±0.67^{c}	19.33±0.88^{a}	14.33±0.88^{b}	9.50±0.50^{c}	8.67±0.67^{c}	***

Means bearing different letters within the same classification, differ significantly (P<0.05).
W = Week, Sig = Significance, *** P<0.001, * P<0.05 and + P<0.1.

Tables 5. Least squares means for carcass traits of growing NZW broiler male rabbits as affected by severe heat stress and ialleviation.

Items (Weights in gram)	Winter	Summer Control	Summer Palm oil	Summer Tafla	Summer Cool water	Sig
Live body	2210.0±60.14	1816.7±67.81	2010.0±59.44	1970.0±78.23	2076.6±76.80	*
Carcass	1165.1±15.58	1150.7±15.71	1146.0±13.59	1186.3±13.71	1176.5±13.79	NS
Empty gut	177.7±5.87	191.0±5.92	181.3±5.12	151.5±5.17	179.3±5.21	***
Fore part	259.8±3.99	259.4±4.02	262.8±3.48	270.3±3.51	276.4±3.53	**
Intermediate part	297.2±8.70	284.3±8.77	287.6±7.59	307.3±7.66	301.7±7.70	NS
Hind part	420.6±8.27	418.2±8.35	423.2±7.21	439.4±7.28	420.8±7.32	NS
Head	128.7±4.28	126.7±4.32	127.1±3.74	122.7±3.77	124.8±3.79	NS
Liver	58.9±5.33	62.1±5.37	45.2±4.65	46.7±4.69	52.9±4.72	+
Kidney	20.2±1.20	11.3±1.21	11.7±1.04	10.8±1.05	11.7±1.06	***
Kidney fat	23.4±2.34	14.3±2.36	18.4±2.04	9.6±2.06	18.7±2.07	**

Sig = Significance, *** P<0.001, ** P<0.01, * P<0.05 and + P<0.1.

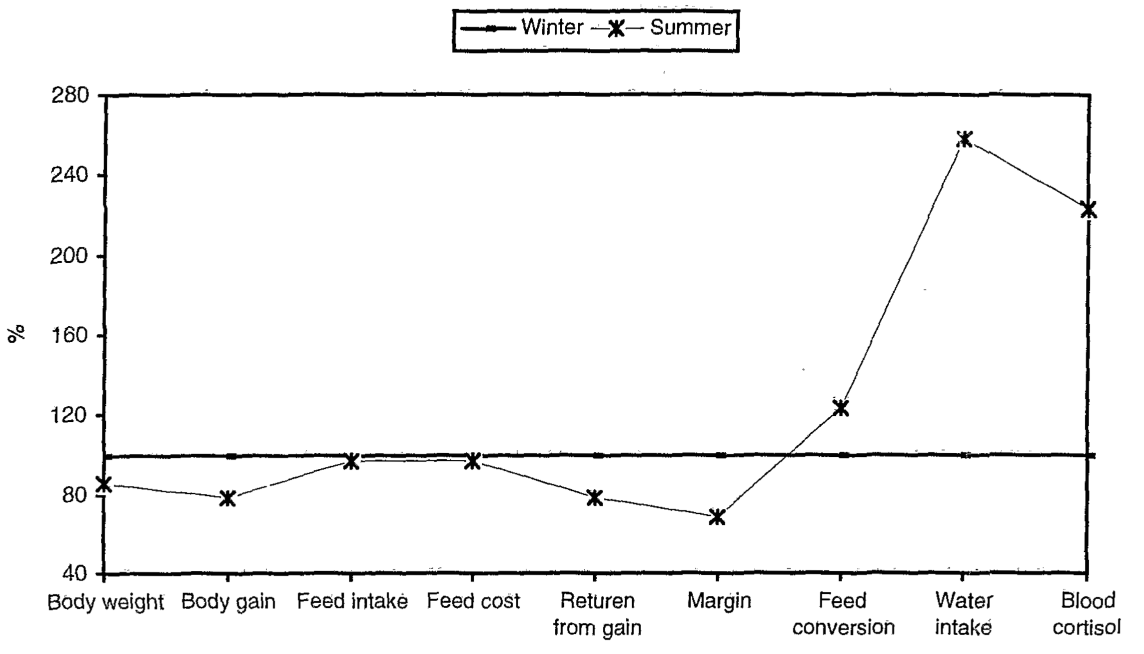

Figure 1. Body gain performance, feed performance and cost, profit analysis and some blood components as affected with summer climate, when considering the values of rabbits reared during winter as 100%.

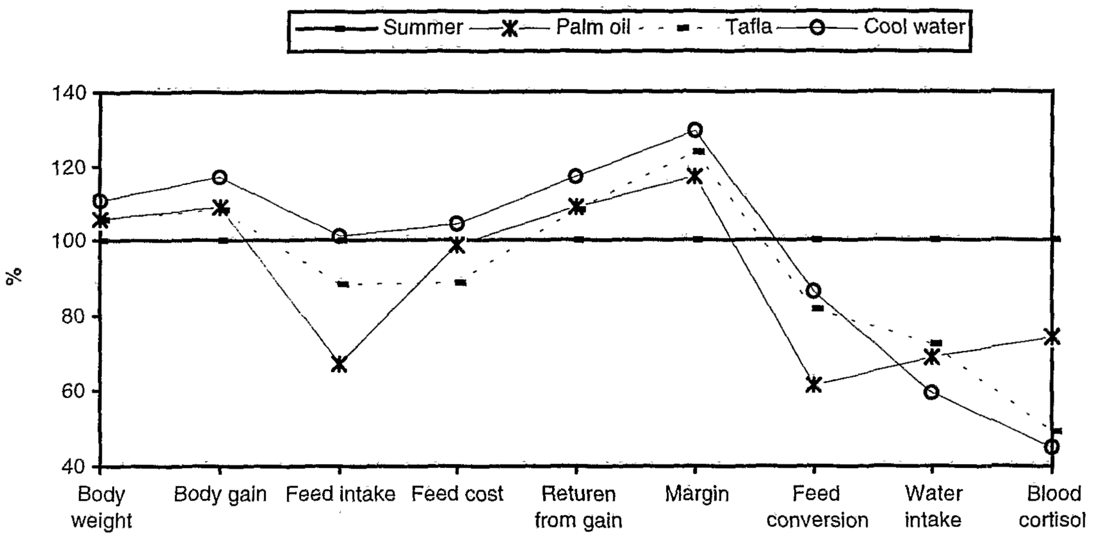

Figure 2. Body gain performance, feed performance and cost, profit analysis and some blood components as affected with physical techniques, when considering the values of rabbits reared during summer (control) as 100%.

passage that increase each of ion exchange capacity, digestibility and absorption, in addition to its reaction with dietary protein forming a complex which has positive effect on protein degradability and improvement of nitrogen utilization that are reflected in the increase in body gain weight (Ayyat and Marai, 1997). Improvement in body gain weight by tafla addition may also be due to the decrease of cortisol concentration in the blood. The decrease in water intake by tafla treatment may be due to the decrease in dry matter intake.

Treatment with drinking cool water (10-15 °C)

Regarding the treatment with drinking cool water, the traits that increased were final live body gain weight (10.77%; $P<0.05$), body gain at 0-7 weeks (17.06%; $P<0.05$), feed intake (1.2%), feed conversion (13.6%) and final margin (29.6%) and weights of carcass (2.3%), fore part (6.5%) and intermediate part (6.1%) and those decreased were water intake (40.6%), respiration rate (5.1%; $P<0.05$), rectal temperature (0.67%; $P<0.05$), plasma total protein (5.9%; $P<0.05$), albumin (10.7%; $P<0.05$) and albumin-globulin ratio (10.3%; $P<0.05$) and weights of empty gut (6.2%), liver (14.9%) and kidney fat (30.4%) (Tables 2-5 and Fig 2). The increase in gain weight by drinking cool water was due to the increase in feed intake and conversion, probably as a result to the increase in animal appetite and physiological functions. Drinking cool water acts through cooling the animals body core by conduction as a result to the difference between temperatures of the drinking water and urine, mediated by cooling the area of the hypothalamus. This is altogether with the high specific heat of water, as well as, body water retention with drinking cool water that help to alleviate the rise in body temperature which are reflected in reduction of rectal temperature and respiration rate. Reduction of water intake by drinking cool water may be due to increase in the dissipated heat. The decrease in plasma components by drinking cool water may be due to increasing haemodilution and activity.

The comparison between the physical techniques used in the presents study showed that drinking cool water (10-15 °C) was the most efficient method for alleviation the heat stressed NZW broiler male rabbits until marketing age, since it showed the lowest respiration rate and cortisol level (become normal) and the highest final body weight, total gain weight and margin percentage.

REFERENCES

AOAC (1980). Association of Official Analytical Chemists. *Official Methods of Analysis*. 13th Edition, Washington, USA.

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

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

Ayyat, M.S. and Marai, I.F.M. (1997). Use of natural clays in animal production. *Proceedings of the International Conference on Animal, Poultry and Rabbit Production and Health*, Cairo, Egypt, pp 91-111.

Duncan, D.B. (1955). Multiple range and multiple F-test. *Biometrics*, **11**: 1-42.

Habeeb, A.A., Marai. I.F.M., El-Sayiad, Gh.A. and Nessem, M.Z. (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): -633.

Marai, I.F.M., Abdel-Samee, A.M. and El-Gafaary, M.N. (1991).Criteria of response and adaptation to high temperature for reproductive and growth traits in rabbits. *Options Mediterraneennes*, Serie Seminares, **17**: 127-134.

Marai, I.F.M. Ayyat, M.S., Gabr, H.A.and Abdel-Monem, U.M. (1996). Effects of heat stress and its amelioration on reproductive performance of New Zealand White adult female and male rabbits, under Egyptian conditions. *6th World Congress*, Toulouse, France, **2**: 197-202.

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

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

NRC (1977). *Nuttrient Requirements of Rabbits.* 2nd Edition, Wasington, D.C., USA.

PORIM (1987). *Palm Oil Research Institute of Malaysia.* Some properties of palm oil. Ministry of Primary Industries, Malaysia, ISBN 967 – 961 –018- 7.

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