EFFECT OF DRINKING WATER TEMPERATURES AND SOME DIETARY FEED ADDITIVES ON PERFORMANCE OF HEAT STRESSED RABBITS

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ABSTRACT

A twelve-treatment experiment was carried out to overcome some of the negative effects of heat stress (> 30.0 °C; 6 hours a day from 12 noon to 6 p.m.) on performance of 120, 7-week-old NZW X Californian rabbits up to the 14th week of age. The interaction between drinking water temperature (normal; NW 29-32°C or cold water; CW of 16-20°C) and studied dietary feed additive [without supplementation (control), or with vitamin C (300 mg/kg diet), potassium chloride (KCl; 0.5%), copper as copper chloride (200 ppm), commercial enzymes mixture (Kemzyme; 1 kg/ton) or glycine (0.5 kg/ton)] was studied in 2 x 6 factorial arrangement. Results indicate that studied water temperatures or feed additives, on average, did not significantly affect total weight gain (WG), feed intake (FI), feed conversion ratio (FCR), rectal temperature, total edible parts (%), plasma glucose, and crude protein (CP) and energy digestibility coefficients (%). While, NW groups, on average, had significantly (P<0.05) higher hot carcass (%) and plasma cholesterol and urea than CW groups. Studied feed additives, on average, significantly affected plasma total lipids, urea and creatinine, and organic matter (OM), ether extract (EE), and crude fiber (CF) digestibility coefficients. There were significant treatment differences (P<0.05) for WG, FI, plasma glucose and urea and EE digestibility coefficients.

Key words: rabbit performance, heat stress, water temperature, feed additives.

INTRODUCTION

Heat stress is the major constraint on animal productivity in arid zones. Growth and reproduction are impaired as a result of the drastic changes in biological functions caused by heat stress (HABEEB *et al.*, 1992). Alleviation of heat load imposed upon rabbit can be carried out through genetic, managerial or nutritional means that help stressed rabbits to express its own genetic potentialities. Supplementing heat stressed rabbits with cool water (HABEEB *et al.*, 1994), vitamin C (EL-GAMAL, 2002; AL-SHANTY, 2003), mineral salts (MARAI *et al.*, 1994; ABDEL-KHALEK, 1999), or enzymes mixture preparations (TAWFEEK, 1996), were found to help rabbits to withstand heat stress. Also, GHAZALAH *et al.* (2000) added a glycine containing electrolyte mixture (Fradehy) to heat stressed rabbit diet and found that glycine could improve performance of heat stressed rabbits by facilitating the absorption of electrolytes that excessively lost during stress episode. The present work aimed at studying the effect of the interaction between drinking water temperature (normal water or cold water; 16-20°C) and dietary feed additive (control, vitamin C, KCl, $CuCl_2$, Kemzyme or glycine) on performance of heat stressed rabbits.

MATERIAL AND METHODS

The study was carried out during July-September, at Animal Production Research Institute Station, Agricultural Research Center, Egypt. One hundred and twenty-7 week old NZW x Californian rabbits were evenly sexed, weighed and individually caged to study the effect of the interaction between drinking water temperature; normal water (NW; control of 29-32°C) or cold water (CW; 16-20°C), each with six experimental diets; without supplementation (control) or with vitamin C (300 mg/kg diet), KCl; 0.5%, copper as $CuCl_2$ (200 ppm), commercial enzymes mixture (Kemzyme; 1 kg/ton) contained alpha-amylase (0.69%), beta glucanase (0.65%), protease (0.37%), lipase (0.43%), cellulase (0.42%), bentonite (7.7%) and carrier up to 100%. or glycine (0.5 kg/ton) in 2 x 6 factorial arrangement on some performance traits of thermally stressed rabbits (>30 °C; 6 hours a day from 12 noon to 6 p.m.). Additives studied were supplemented on the expense of total diet. Formula (NRC, 1977), composition and chemical analyses of the basal diet are presented in Table 1.

Table 1. Ingredients and composition.

Ingredients	% (fresh)	Calculated analyses	
Wheat bran	34.5	DE	2659 kcal/kg
Clover hay	14.0	Moisture	8.40 %
Yellow corn	17.5	CP	16.08 %
Soybean meal (44 % CP)	17.0	CF	13.27 %
Bean straw	12.0	EE	2.60 %
Molasses	2.2	Calcium	1.08 %
Limestone	1.7	Phosphorus	0.52 %
Sodium chloride	0.5	Lysine	0.86 %
Vitamins and minerals mixture *	0.4	Methionine and Cystine	0.70 %
DL-Methionine	0.2		

*Supplied per kg. of diet: 12000 IU vit.A; 2200 IU vit. D_3; 10 mg vit. E; 2.0 mg vit. K_3; 1.0 mg vit. B_1; 4.0 mg vit. B_2; 1.5 mg vit. B_6; 0.0010 mg vit. B_{12}; 6.7 mg vit. PP; 6.67 mg vit. B_5; 0.07 mg B_8; 1.67 mg B_9; 400 mg Choline chloride; 133.4 mg Mg; 25.0 mg Fe; 22.3 mg Zn; 10.0 mg Mn;1 .67 mg Cu; 0.25 mg I and 0.033 mg Se.

Determined proximate analyses were done according to AOAC (1990), while, total gross energy of feed and feces was determined using Ballistic Bomb Calorimeter for further estimation of DE. CW was offered twice or three times a day, only during the stress period. To avoid destruction during pelleting process, vitamin C was daily dissolved in about 20 ml water, and then the solution formed was sprayed over daily-pelleted feed offered. Kemzyme was manufactured by Kemin Industries, USA. Gas and electric heaters were used to keep the rabbitry temperature over the minimum required temperature. Four rabbits (2 males and 2 females) were chosen from each treatment, fasted for 12 hours, then slaughtered during stress period (12 noon-6 p.m.) for blood plasma analyses determination and to estimate the hot carcass and total edible parts (hot carcass+head+liver+kidneys+heart) percentages. Digestion trials were performed using 3 rabbits of each treatment. Data were subjected to a 2x6 factorial analysis using SAS (1990). Variables having significant differences were compared using Duncan's Multiple Range Test (STEEL and TORRIE, 1960).

RESULTS AND DISCUSSION

The recoded rabbitry temperature throughout the experimental period was ranged between 31.4±0.8°C during stress period.

Growth performance, rectal temperature and carcass and total edible parts percentages.

Results in Table 2 indicate means of WG, FI, FCR, rectal temperature at 11 and 14 weeks of age, and total edible parts (%) were not significantly affected by either studied main factors (drinking water temperature or feed additive), also hot carcass % was significantly ($P<0.05$) higher for NW groups compared with CW groups, but it was not affected by studied feed additives.The interaction between studied drinking water temperatures and studied feed additives did significantly ($P<0.05$) affect LWG and FI, control+CW and KCl+NW groups, showed the highest recorded WG and FI, respectively, while, glycine+NW group showed the lowest WG and FI of studied treatments. No statistical differences in FCR, rabbits' rectal temperatures at 11 and 14 weeks of age, hot carcass and total edible parts percentages were detected between treatments under study.

HABEEB *et al.* (1994) and MARAI *et al.* (1994) suggested that the beneficial effect of drinking cool water in reduction of the heat load is due to the heat dissipated by conduction as a result to the difference between the drinking cool water and urine temperature. Moreover, drinking cool water is an excellent cooling agent because of its high latent heat of vaporization. While, vitamin C supplementation under stress conditions inhibit enzymes involved in gluco-corticoids production, corticosterone negatively affects growth and immune functions of stressed animals (PARDUE *et al.* 1985). Copper could enhance rabbit performance through thinning of the cecal wall, hence improve nutrients uptake (KING, 1975) and decrease mortality from enteritis under heat stress conditions (PATTON *et al.* 1982). Kemzyme supplementation may improve performance via compensation for the decrease in endogenous enzymes secretions associated with heat stress. In this concern, TAWFEEK (1996) reported that enzymes mixture incorporated in Kemzyme formula work synergistically to improve the nutritive values of diets, thus improve rabbit growth performance.

However, statistically, results of the studied main factors do not supported previous reported works, some individual treatment, statistically, achieved the expected results compared with the control group drank tap water.

Table 2. Effect of studied feed supplements and drinking water temperatures on rabbits growth performance, rectal temperature, carcass and total edible parts percentages.

	Initial live weight (g)	Total weight gain (g)	Feed intake (g)	Feed conversion ratio	Rectal temperature (°C) 11 weeks old	Rectal temperature (°C) 14 weeks old	Carcass (%)	Total edible Parts (%)
Control								
NW	828±26	816^{BCD}±23	3212^{BC}±128	3.93±0.07	40.52±0.53	39.70±0.24	54.4±0.9	64.7±0.7
CW	830±30	930^{A}±43	3560^{ABC}±80	3.87±0.17	39.80±0.08	39.60±0.23	52.0±0.7	62.3±0.8
Average	**829±19**	**866±26**	**3364±90**	**3.90±0.08**	**40.16±0.28**	**39.65±0.16**	**53.2±0.7**	**63.5±0.7**
Vitamin C								
NW	831±26	883^{ABCD}±44	3269^{BC}±121	3.75±0.18	39.80±0.20	39.85±0.13	53.5±0.3	63.9±0.5
CW	830±27	903^{ABC}±42	3609^{AB}±82	4.04±0.17	39.73±0.13	39.95±0.29	53.0±0.5	63.9±0.5
Average	**831±19**	**893±30**	**3438±83**	**3.89±0.13**	**39.76±0.11**	**39.90±0.15**	**53.2±0.3**	**63.9±0.5**
KCl								
NW	831±26	874^{ABCD}±24	3739^{A}±86	4.29±0.12	39.73±0.11	39.63±0.29	54.6±1.1	64.4±1.0
CW	833±31	812^{CD}±30	3368^{ABC}±181	4.15±0.17	39.68±0.17	39.75±0.19	53.0±0.7	63.4±0.8
Average	**832±20**	**843±20**	**3554±108**	**4.22±0.10**	**39.70±0.09**	**39.69±0.16**	**53.8±0.6**	**63.9±0.6**
$CuCl_2$								
NW	829±36	920^{ABC}±35	3613^{AB}±102	3.96±0.15	39.70±0.09	39.65±0.09	53.1±1.1	63.3±1.0
CW	831±33	856^{ABCD}±20	3263^{BC}±149	3.81±0.13	39.93±0.17	39.55±0.21	52.5±0.7	63.1±1.0
Average	**830±24**	**886±21**	**3428±100**	**3.88±0.10**	**39.81±0.09**	**39.60±0.11**	**52.8±0.6**	**63.2±0.6**
Kemzyme								
NW	833±30	888^{ABCD}±29	3409^{ABC}±108	3.85±0.08	39.93±0.09	39.65±0.12	53.4±0.8	64.1±0.7
CW	832±29	927^{AB}±47	3593^{AB}±162	3.89±0.07	39.78±0.09	39.90±0.14	53.3±0.8	63.8±0.6
Average	**833±21**	**908±27**	**3501±97**	**3.87±0.05**	**39.85±0.06**	**39.78±0.09**	**53.3±0.5**	**63.9±0.4**
Glycine								
NW	830±29	789^{D}±28	3173^{C}±67	4.05±0.15	39.98±0.10	39.85±0.18	53.4±1.1	63.6±1.1
CW	830±35	911^{ABC}±36	3528^{ABC}±145	3.89±0.12	40.13±0.27	40.10±0.37	52.1±0.9	62.8±1.0
Average	**830±22**	**857±27**	**3370±94**	**3.96±0.04**	**40.05±0.13**	**39.98±0.20**	**52.8±0.7**	**63.2±0.7**
Water temp.								
NW	**830±12**	**861±14**	**3398±51**	**3.97±0.06**	**39.94±0.11**	**39.72±0.07**	**53.7^{A} ±0.4**	**64.0±0.3**
CW	**831±12**	**889±15**	**3484±58**	**3.94±0.06**	**39.84±0.07**	**39.81±0.10**	**52.6^{B} ±0.3**	**63.2±0.3**

A, B.. means in the same column within each factor differently superscripted are significantly different ($P<0.05$)

Blood constituents, nutrient digestibility coefficients and energy utilization.

Results presented in Table 3 show that rabbits of NW groups significantly had higher plasma cholesterol and urea compared with those of CW drank groups. On the other hand, except that glycine supplementation increased plasma total lipids ($P<0.05$), glucose and creatinine ($P<0.05$), and that copper supplementation, also increased plasma total; cholesterol and urea ($P<0.05$), all studied feed additives decreased studied plasma traits compared with the control. The interaction studied significantly affected plasma glucose and urea. BASSUNY (1991) suggested that higher copper levels in rabbit diets may cause liver and kidneys injury that may result in higher blood liver and kidney functions.

Table 3 indicates that while drinking water temperature had no significant effect on digestibility coefficients of OM, EE, CP and CF and energy utilization. Studied feed additives, except glycine, showed almost comparable nutrient digestibility coefficients and energy utilization to those of the control. The interaction studied only did significantly affect EE digestibility.

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Table 3. Effect of studied feed supplements and drinking water temperatures on some blood constituents (mg/dl), nutrients digestibility coefficients and energy utilization (%).

Items	Total lipids	Cholesteroll	Glucose	Urea	Creatinine	OM	EE	CP	CF	Energy utilization
Control										
NW	565±78	79±10	113^{BC}±7	54.3^{BC}±3.1	0.39±0.05	66.3±1.1	94.0^{A}±0.2	73.7±1.9	22.7±2.3	67.7±1.6
CW	649±59	79±6	139^{AB}±14	47.7^{BCD}±4.5	0.39±0.03	67.8±1.7	91.8^{AB}±0.4	79.1±0.6	25.3±4.9	68.9±1.8
Average	**607^{B}±48**	**79±5**	**126±9**	**51.0^{B}±2.8**	**0.39^{A}±0.03**	**67.1^{A}±1.0**	**92.9^{A}±0.5**	**76.4±1.5**	**24.0^{A}±2.3**	**68.3±1.1**
Vitamin C										
NW	572±59	74±5	105^{C}±5	48.7^{BC}±2.9	0.42±0.02	66.4±0.1	91.4^{AB}±1.0	75.5±0.4	26.6±0.1	66.1±0.4
CW	535±58	72±6	142^{AB}±4	45.5^{CD}±1.1	0.35±0.01	64.7±1.3	91.4^{AB}±0.7	76.7±1.5	16.7±2.5	67.2±1.1
Average	**554^{B}±39**	**73±3**	**124±8**	**47.1^{B}±1.6**	**0.38^{AB}±0.02**	**65.5^{A}±0.7**	**91.4^{AB}±0.6**	**76.1±0.8**	**21.6^{A}±2.5**	**66.7±0.6**
KCl										
NW	425±19	74±6	113^{BC}±11	50.7^{BC}±3.9	0.29±0.02	65.0±0.4	86.4^{DE}±1.4	75.7±0.3	24.9±1.6	65.7±0.8
CW	675±59	70±7	**137^{AB}±8**	45.4^{CD}±1.1	0.33±0.03	65.4±1.2	85.3^{E}±2.0	80.2±1.8	20.3±1.1	67.9±2.1
Average	**550^{B}±55**	**72±4**	**125±8**	**48.1^{B}±2.1**	**0.31^{C}±0.02**	**65.2^{A}±0.6**	**85.9^{C}±1.1**	**78.0±1.3**	**22.6^{A}±1.4**	**66.8±1.1**
$CuCl_2$										
NW	543±81	96±9	116^{BC}±7	71.4^{A}±1.5	0.38±0.04	67.5±1.6	88.9^{BCDE}±1.7	78.1±2.6	26.1±3.3	67.6±1.0
CW	478±43	64±7	124^{ABC}±8	45.4^{CD}±2.7	0.338±0.03	65.7±1.9	90.5^{ABCD}±1.8	74.4±4.5	22.8±3.8	67.9±0.7
Average	**511^{B}±42**	**80±8**	**120±5**	**58.4^{A}±5.1**	**0.35^{ABC}±0.02**	**66.6^{A}±1.2**	**89.7^{B}±1.2**	**76.3±2.5**	**24.5^{A}±2.4**	**67.8±0.5**
Kemzyme										
NW	550±27	69±9	133^{ABC}±12	56.8^{B}±3.1	0.28±0.02	67.3±0.2	91.2^{ABC}±0.5	77.9±1.3	23.0±1.1	67.1±1.7
CW	500±85	52±4	119^{BC}±13	38.7^{D}±1.9	0.35±0.03	64.5±1.1	86.9^{CDE}±0.3	73.9±2.4	25.2±1.8	66.9±0.6
Average	**525^{B}±42**	**61±6**	**126±8**	**47.8^{B}±3.8**	**0.32^{BC}±0.02**	**65.9^{A}±0.8**	**89.0^{B}±1.0**	**75.9±1.5**	**24.1^{A}±1.1**	**67.0±0.8**
Glycine										
NW	806±62	70±9	152^{A}±7	53.8^{BC}±4.1	0.36±0.04	61.1±0.3	80.7^{F}±2.4	76.1±1.8	13.7±1.5	65.0±0.1
CW	763±37	60±5	122^{ABC}±8	44.3^{CD}±3.8	0.47±0.04	63.8±0.2	88.2^{BCDE}±1.4	76.9±0.5	14.4±0.9	66.9±0.9
Average	**785^{A}±34**	**65±5**	**136±7**	**49.0^{B}±3.1**	**0.41^{A}±0.03**	**62.5^{B}±0.6**	**84.5^{C}±2.1**	**76.5±0.8**	**14.0^{B}±0.8**	**65.9±0.6**
Water temp.										
NW	**577±32**	**77^{A}±4**	**122±5**	**55.9^{A}±1.9**	**0.35±0.02**	**65.6±0.6**	**88.8±1.1**	**76.2±0.7**	**22.9±1.2**	**66.5±0.5**
CW	**600±30**	**66^{B}±3**	**131±4**	**44.5^{B}±1.2**	**0.37±0.01**	**65.3±0.6**	**89.0±0.7**	**76.9±0.9**	**20.8±1.4**	**67.6±0.5**

A, B…means in the same column within each factor differently superscripted are significantly different ($P<0.05$).