EFFECT OF SHORT HEAT EXPOSURE, BALANCED FEED RESTRICTION AND ACETIC ACID SUPPLEMENT AT POST WEANING ON GROWTH AND THERMOREGULATION IN GROWING RABBITS DURING HOT SEASON

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ABSTRACT

The aim of this study was to examine hypothesis that thermal or other stressors (like nutritional deficiencies and acidosis in the gut) at the moment of weaning may be beneficial in post-weaning growth and thermoregulation in later stage of rabbit life during summer season. Eighty New Zealand White rabbit kits were weaned at 30 days of age with average weight of 606.9±26.6 g. At the moment of weaning kits were divided into 4 groups: 1st group, kits were kept as control (control); 2nd group, kits were fed a restricted diet during the 1st week post weaning (restriction); 3rd group, kits were exposed to high ambient temperature (34±2^{o}C) for 1 hour (heat); 4th group, kits were supplemented with 0.5% acetic acid in drinking water (acetic). During the first week post-weaning, feed intake was increased by 10.6% and 1.8% in acetic and heat groups in comparison with the control, respectively. Feed restriction during the first week post-weaning led to reduction in live body weight and body weight gain. Although weaning in rabbit is often associated with lower weight gain, the body weight, and body weight gain in the 1st, 2nd and 4th week post-weaning in kits of heat exposure and acetic acid groups were higher than in the control group. Increases in body weight and body weight gain in the heat group may be attributed to immediate compensatory growth with higher feed intake that followed the reduction in growth during thermal conditioning. Body weight and body weight gain in the 10th week of age under hot summer season in acetic acid and restriction groups were higher than those in control in the 10th week of age during high ambient temperature (41^{o}C). Rectal temperature of rabbits in the control group was greater than that in other groups. Under the same condition, hydrogen peroxide (H_2O_2) and nitric oxide (NO) in plasma increased in heat group but decreased in feed restriction and acetic acid groups compared with the control group. Total antioxidant capacity and catalase in plasma of all treated groups were higher than in the control group. In conclusion, short heat exposure or balanced feed restriction and acetic acid supplement at the moment of weaning led to the improvement in post weaning growth and in thermo-tolerance during summer season in rabbits.

Key words: Feed restriction, Short heat exposure, Acetic acid, Feed conversion, Rectal temperature, Oxidative stress profile.

INTRODUCTION

In rabbits, growth and feed traits are generally low at the post weaning period compared with growing period, also diarrhea and total mortality are high (Lukefahr *et al*., 1983). After weaning, non-specific enteropathies arise in reared rabbits. These troubles lead to a dysfunction in the intestinal tract of rabbits (Laurence *et al*., 2003). On the other hand, at physiological level thermoregulatory status correlated with feeding at the weaning onset as reported by Gerrish *et al*. (1998). Exposure of the growing rabbit to heat stress during summer adversely effected their growth (Marai *et al*., 2001). This may be due to the increase in levels of superoxide anions, hydrogen peroxide and nitric oxide, as well as due to the increase in lipid peroxidation products that have been found in various cells after exposure to heat (Matsumoto *et al*., 1999).

It has been established that the weaning of rabbits is often associated with little weight gain. Also, growing rabbits during hot season are suffering from the heat stress and their growth is lower. Thermal pre-conditioning associated with the synthesis of heat shock proteins (HSP) enhances the animal survival in rats (Villar *et al.,* 1994), as well as the thermotolerance under hot condition in rabbits (Abdel-Kafy, 2006). So, thermal or other stressors (like nutritional deficiencies and acidosis in the gut) at the moment of weaning may be beneficial for the growth after weaning and thermoregulation in later stage of life of rabbits during summer season.

MATERIALS AND METHODS

This work was carried out at a commercial farm in Cairo Governorate, Egypt. The work lasted for 10 weeks in hot season (May to September, 2007). In total 80 New Zealand White (NZW) rabbit kits were used. Kits were weaned at 30 days of age with average weight of 606.9±26.6 g. At the moment of weaning kits were divided into 4 groups (each group of 20 kits) as follows: 1st group: kits were kept as the control (Control); 2nd group: kits were fed restricted diet (≈75% of ad-libitum intake) during the first week post weaning (Restriction); 3rd group: kits were exposed to a high ambient temperature (34±2^{o}C) for 1 hour using electric heaters equipped with thermostat and thermometer (Heat); 4th group: kits were supplemented with 0.5% acetic acid in drinking water (Acetic). Feed intake was recorded during the first week post weaning. Weights of kits were recorded weekly from weaning until the 10th week of age. At 10 weeks of age under hot ambient temperature (41^{o}C), plasma samples obtained and stored at -80^{o}C until oxidative stress profile parameters were assayed. Also the rectal temperature was measured in all rabbits by digital thermometer.

In plasma, parameters of oxidative stress profile were assayed by colorimetric techniques using commercial kits (Biodiagnostic, Egypt). Total antioxidant capacity (mmol/l) in plasma and activity of catalase (U/g) in liver were determined according to Koracevic *et al*. (2001) and Aebi (1984), respectively. Oxidative damage parameters in plasma included lipid peroxides (nmol/ml), nitric oxide (µmol/l) and hydrogen peroxide (mmol/l). These parameters were determined as described by Ohkawa *et al*. (1979), Schabel *et al*. (1961) and Aebi (1984), respectively.

Statistical Analysis

All results were analyzed using the general linear models procedure of SAS (1999). The model $Y_{ij} = \mu + G_i + e_{ij}$ included G_i =effects heat treatment, e_{ij}= residual error term, and μ = the overall mean.

RESULTS AND DISCUSSION

Feed intake and feed conversion

During the first week post-weaning, the feed intake was increased by 10.6% in acetic acid supplementation (Acetic) group (Figure 1). Similar results were found by Abdel-Azeem (2005) who reported that total feed intake of rabbits tended to be higher (+15.2%) for the group receiving acetic acids compared to the control group. Whereas acidification of the gut of non-ruminants allows for improved digestion of nutrients and the inhibition of growth of potentially gut bacteria, the latter feature may show health benefits in production (BASF, 2001). Slight increase (1.8%) of the feed intake in short heat exposure (Heat) is in agreement with findings of Uni *et al*. (2001) who reported that the feed intake was reduced in chicks during 5 days after thermal treatment, but it was increased relatively to that of control chicks. Short-term exposure to heat at the moment of weaning led to improvement in the feed conversion, while feed restriction had a negative effect on the feed conversion (Figure 2). These results agree with results of Uni *et al*. (2001). They stated that the short-term exposure to heat during early-age resulted in growth retardation followed by immediate compensatory growth with higher feed intake that completely counteracted the decrease in weight gain (Yahav and Plavnik, 1999; Uni *et al*., 2001).

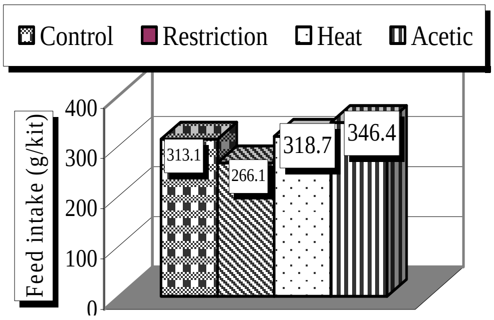

Figure 1: Feed intake (g/kit) during the first week post-weaning in NZW rabbits

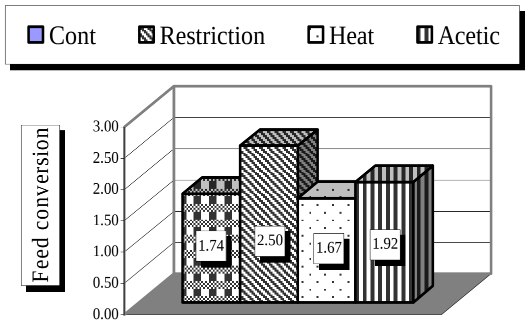

Figure 2: Feed conversion during the first week post-weaning in NZW rabbits

Body weight and body gain

Feed restriction during the first week post-weaning reduced live body weight and body weight gain (Table 1). After weaning, dietary feed/energy level seems to be an important factor for regulation of body growth and development. However, a feed restriction before six weeks of age seems to delay skeletal development (Beauchene *et al*., 1986). Although weaning in rabbits is often associated with low weight gain, and in some instance with diarrhea and morbidity (Ozimba and Lukefahr, 1991), the body weight, and body weight gain in the 1st, 2nd and 4 week post-weaning in kits of heat exposure and acetic acid groups were higher than in control group. The same trends were reported in heat exposure and acetic acid groups by Uni *et al*. (2001) and Abdel-Azeem (2005), respectively.

Table 1: Body weight and body weight gain as affected by feed restriction, heat exposure and acetic acid supplement in NZW rabbits

	Control	Restriction	Heat	Acetic
Weight (g) at:				
weaning	602.3±26.6	600.3±26.6	641.0±26.6	584.0±26.6
Wk1	774.2± 33^{ab}	706.6±32^{b}	832.3±32^{a}	786. 7±34^{ab}
Wk2	935.7±49.3	920.3±45.9	970.7±47.5	962.6±49.3
Wk4	1207.2±51b	1278.3±44^{ab}	1374.2±44^{a}	1349.5±48^{a}
Wk10	1971.0±65.9	1981.5±57.8	1938.6±62.9	2013.7±60.2
Body weight gain (g) at:				
Wk1	180.4±13.3^{a}	106.3±12.8^{b}	191.3±12.8^{a}	180.2±13.8^{a}
Wk2	333.0±35.4	320.0±32.9	330.3±34.1	356.1±35.4
Wk4	603.2±39.0^{b}	692.6±34.2^{ab}	730.7± 34.2^{a}	714.5±37.2^{a}
Wk10	1367.0±68.3	1395.7±59.9	1307.2±65.1	1393.7±62.3

^{a,b} Values having different superscripts within the same row are significantly different ($P<0.05$)

Increase in body weight and body gain in heat group may be attributed to immediate compensatory growth with higher feed intake (Figure 1) that followed the reduction in growth under thermal conditioning. The same phenomenon was found in broiler chicks as reported by Yahav *et al*. (1997). Partanen and Mroz (1999) showed that several organic acids had positive influence on rabbit growth performance. Improvement in body weight, as a result of adding the studied organic acids, may be attributed to the acid anion that was shown to complex with Ca, P, Mg and Zn. This result may be related to an improvement in digestibility of these minerals. Furthermore, organic acids serve as substrates in the intermediary metabolism. Acetic acid supplement during the 1st week post weaning increased the body weight and body weight gain at the 10th week of age under hot summer season (Table 1). This may be related to the fact that organic acids change enteric flora and reduce *Escherichia coli* counts (Pollman, 1986; Abdel-Azeem, 2005). Feed restriction during the 1st week post weaning can be related to the increase in body gain from the 4th (weaning) to the 10th week of age under hot summer season (Table 1). This may be due to the increase of the HSP 70 density in broiler chicks feed-restricted at early age (Liew *et al*., 2003). This result may confirm that thermoregulatory status correlated with weaning onset (Gerrish *et al*., 1998), thus reflected in the litters' weight of restriction and acetic group (Table 1).

Rectal temperature

During high ambient temperature (41°C) the rectal temperature of rabbits in control group was greater than that in treated groups (Figure 3). Increasing rectal temperature in controls may be due to increasing nitric oxide (Table 2). Lacerda *et al*. (2006) reported that increasing nitric oxide induced a significant increase in core temperature and decreases running performance in rats. Also, central NO transmission exerts important effects on thermoregulation by increasing the heat dissipation through peripheral vasodilatation, preventing heat storage and protecting the brain against excessive hyperthermia (Lacerda *et al*., 2005). We confirmed the decrease NO in restriction and acetic groups (Table 2). The reduction of the rectal temperature in heat group (Figure 3) may be due to the fact that rabbits were able to maintain constant rectal temperature during heat exposure by low metabolic rate when previously acclimated to high temperature (Oliveira *et al*., 1985).

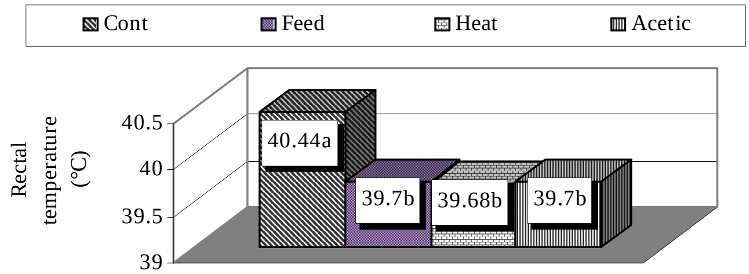

Figure 3: Rectal temperature in the 10th week of age under hot season as affected by feed restriction, heat exposure and acetic acid supply post weaning

Oxidative stress parameters

Short heat-exposure of the kits at the moment of weaning (1 h) led to the increase in hydrogen peroxide (H_2O_2) and nitric oxide (NO) plasma concentrations compared to other groups (Table 2). Contact, feed restriction and acetic acid during 1st week post weaning caused reducing in hydrogen peroxide and nitric oxide as compared with control group in rabbits at 10 weeks of age. Mechanisms of acidosis induced in the small intestine involve up-regulation of NO production by increased expression of inducible NO synthase (iNOS), and augmentation of superoxide radicals and myeloperoxidase activity (Pedoto *et al*., 2001). On the other hand, the integrated mechanisms between different cellular signalings (such as H_2O_2 and NO) and responses, and transcription factor activation of stress protein that accompany aging exist (Zhang *et al*., 2006). Total antioxidant capacity (mmol/l) and catalase (as antioxidative enzyme) activity in plasma of all treated group was higher than that control group under hot condition. The partial resistance to hyperthermia was correlated with higher antioxidative capacity of apoptotic cells as reported by Dörthe *et al*. (2000) in rats. Also, catalase enzyme as an antioxidative enzyme was induced for protecting the whole-body against ischemia and reperfusion injury caused by hyperthermia (Yamashita *et al*., 1998).

Table 2: Oxidative damage parameters, antioxidant capacity and catalase enzyme in plasma as affected by feed restriction, heat exposure, and acetic acid supplement in rabbits at 10 weeks of age

Items	Control	Restriction	Heat	Acetic	±SE
Oxidative damage parameters					
Hydrogen peroxide (mmol/l)	0.293^{b}	0.202^{bc}	0.454^{a}	0.157^{c}	0.047
Nitric oxide (µmol/l)	71.2^{b}	33.3^{d}	97.7^{a}	43.7^{c}	3.04
Antioxidant capacity (mmol/l)	1.93^{c}	2.18^{a}	2.00^{bc}	2.16^{ab}	0.05
Catalase (U/l)	181.3^{b}	323.6^{ab}	481.9^{a}	298.2^{b}	52.3

a,b,c,d Values having different superscripts within the same row are significantly different (P<0.05)

CONCLUSIONS

Our results indicate that a short heat exposure or balanced feed restriction and acetic acid supplement at the moment of weaning may be beneficial in growth post weaning in rabbits. Also, these treatments resulted in rabbits more adapted and with better thermo-tolerance under summer season.

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