TEMPERATURE HUMIDITY INDEX AND PHYSIOLOGICAL RESPONSES OF LOCAL RABBIT OFFERED DIFFERENT LEVEL OF ENERGY AND PROTEIN FEEDS AND HOUSED IN TWO CAGE SYSTEMS

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ABSTRACT

An experiment was carried out to study temperature humidity index (THI) and physiological responses of local rabbit offered different level of energy and protein feeds and housed in two cage systems. A split – plot design consisted of two main plot : under ground shelter and battery housing system and four diets as sub plot with different energy and protein level. The result show that, under ground shelter cage produced lower (P<0.05) THI than the battery cage (26.17 vs. 27.69). The lower THI in under ground shelter cage than battery cage causing physiological responses better to the rabbits. Diets with different energy and protein level did not give significant effect on THI, skin temperature and rectal temperature (P>0.05). It was observed that there is a significant interaction (P<0.05) between cage system and ration on respiration rate. Diets did not have any significant effect (P>0.05) on respiration rate of the rabbit housed under ground shelter cage. But converse was true for battery cage. Diets containing 2800 kcalME/kg and 18,50% crude protein causing significantly higher (P<0.05) respiration rate than other diets. It was concluded that under ground shelter cage give a better responds than battery cage. Diets differing in energy and protein level did not affect temperature-humidity index. Further, diets with 2800 kcalME/kg and 18.50% crude protein gave less physiological impact than those diets containing 2600 kcalME/kg and 17% crude protein, 2400 kcalME/kg and 15.50% crude protein, 2200 kcalME/kg and 14% crude protein.

Keywords : Domestic Rabbit, Temperature-Humidity Index, Physiological Responses

INTRODUCTION

Rabbit business development is a strategic breakthrough in the field of animal husbandry to accelerate the achievement of food self-sufficiency especially adequacy of animal protein. Ogunjimi *et al*. (2008) reported that the domestic rabbit have been recommended as a good alternative source of dietary protein for the constant increased of the population in developing countries due to their short-cycled production characteristics. McNitt *et al*. (1996) reported that in hot climate regions rabbit production has same problems such as heat stress, low quality food, diseases and parasites and among these, heat stress is the most important factor. Ogunjimi *et al*. (2008) reported that the relationship of environmental temperature, relative humidity, energy intake and heat production in growing animal is fundamental factor that must be considered in designing and managing of an efficient livestock production.

It was suggested that the optimal temperature humidity index for the rabbit husbandry is 27,8 (Marai, 2002). The optimal temperature for rabbit is 9 – 19^{o}C (McNitt *et al*.,1996) and the optimum relative humidity is around 80 -86% (Kamal *et al*., 2010). BMKG (2010) reported that environmental temperature at low land in humid tropics is 21,87 – 31,13^{o}C and relative humidity is 79 - 86%. Biological thermoregulation in rabbits is rather poor as they only have few sweat glands. In heat stressed, both respiration rate and pulse rate are increased in rabbits (Skriivanova *et al*., 2011). Diet with different energy and protein level, increase respiration and pulse rates to increase oxygen supply for body cells (Kasa, 1998). This study to investigate temperature humidity index and physiological responses of local rabbit offered different level of energy and protein feeds and housed in two cage system was defined increase growth rate of rabbits through the selection of an appropriate cage and improved physiological response.

MATERIALS AND METHODS

Rabbits. Thirty two male domestic rabbits of five week old, with nearly equal live body weight (189.25 g ± 1.54) was used in this experiment. sixteen rabbits maintained in under ground shelter cages and sixteen in battery cages. Each cage was provided with feed and water containers. The rabbit cage size is 70 × 50 cm wide, with 45 cm height.

Feed and Water. Feed were formulated using a mixture of yellow corn, rice bran, palm waste, fish meal, soy flour, cassava, elephant grass, waste wood saws, copra meal, mineral mix and bone meal. Feeds with different energy and protein level is made in the form of pellets. Feed containing 2200 kcal/kg ME and 14.00% crude protein (R1), 2400 kcalME/kg and 15.50% crude protein (R2), 2600 kcalME/kg and 17.00% crude protein (R3), 2800 kcalME/kg and 17.50% crude protein (R4). Feed and water were provided *ad libitum*, feed and water intake were weighed and recorded every day.

Data Recording. THI and physiological responses were recorded three times a day at 7.30 am, 13.30 pm and 17.30 pm. THI were calculated following Marai (2002) formulation:

$THI = T - [(0.31 - 0.31 \times Rh)(T - 14.4)]$, Where THI : Temperature Humidity Index, T : Temperature (^oC) and Rh : Relative humidity/100.

Design of the experiment and statistical analyses. Randomized block design with a split-plot pattern of 2 x 4 and four replicates was used in this experiment. All data were recorded, tabulated, and analyzed using analysis of variance. Whenever significantly differences were found, analyses will be continued using Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULT AND DISCUSSION

Data of the Rabbits housed under ground shelter cage (K0) where Temperature Humidity Index (THI) was significantly lower ($P < 0.05$) than those battery cage (K1), as present in Table 1. K1 is the cages stage enclosure having a height of 75 cm from the ground surface, cause received of the long-wave radiation (heat) was higher than the K0 cage (Lean and Rin, 1996). This is due to the fact that the temperature in K1 cage was higher ($P < 0.05$) than K0 cage (28.71 °C vs. 27.12 °C). Higher temperatures increased water evaporation in the cage so that the relative humidity in the K1 cage is higher than the K0 cage (76.33% vs. 75.51%). The higher temperature and relative humidity in the K1 cage, resulting THI in K1 cage was higher ($P<0,05$) than the K0 cage. No significant differences was found ($P> 0.05$) between the rations treatment with different protein and energy levels to THI (Table 2). The diets with different protein and energy levels did not have any significant effect on the temperature and humidity in the cage. The same report was state by Marai *et al*. (2002) that temperature and humidity were factors determining the value of THI. Diets given to the rabbit did not have significantly affect to the temperature and humidity in the cages (Table 2).

Table 1 showed that domestic rabbit has a pulse rate of 108.15 times / min - 125 times / min. This results are in line with the result reported by Kasa *et al*. (1997) that new zealand white rabbits reared in cage with temperature 21.1 ° C cause pulse rate 76 times /min, while at temperatures of 35 ° C was 421 times / min. In this experiment, rabbits that was reared in battery cages had pulse rate higher than those housed under ground shelter cage (121.77 times /min vs. 106.89 times / min). The role of heart as an organ that serves to balance the body's heat was reported by Mahardika, (1996) and Carvera and Carmona (1998). Data in Table 1 shows the value of THI at K1 cage higher than K0 cage, resulting heat stress levels of domestic rabbit on K1 cage is higher than the K0 cage. Yousef (1987) reported that the faster pulse rate cause the faster body heat circulation to the surface of the skin which would then be released into the environment. Diet on treatment R4 causing pulse rate higher than there R3, R2 and R1. Rabbits fed diet R4 consumed highest energy (297.68 kcal / day) compared to those R3 (286.53 kcal /day), R2 (248.92 kcal /day) and R1 (212.77 kcal /day). Kasa (1998) suggested that an increase the rate of metabolism in the body require higher oxygen supply so the pulse rate increased.

Table 1
Temperature- Humidity Index and Physiological Responses of Rabbit Housed at Under Ground Shelter and Battery Cage

Variable	Treatment		
	K0	K1	SEM
Cage Temperature (^{o}C)	27.12^{b}	28.71^{a}	0.06
Cage Humidity (%)	75.51^{b}	76.33^{a}	0.05
Temperature-Humidity Index (THI)	26.17^{b}	27.69^{a}	0.07
Pulse Rate (times/min)	106.89^{b}	121.77^{a}	1.78
Rectal Temperature (^{o}C)	39.12^{a}	39.24^{a}	0.05
Skin Temperature (^{o}C)	37.28^{b}	39.03^{a}	0.28

1) K0: Under Ground Shelter Cage
   K1: Battery Cage
2) The same superscripts in the same row indicate no significant difference (P> 0.05) and different superscripts in the same row indicate significant difference (P <0.05)
3) SEM : Standard Error of the Treatment Means

The rectal temperatures of the rabbit housed in K0 and K1 was 39.12 °C and 39.24 °C respectively. This is results are similar to the reported by Bivin and King (1995) who found an average rectal temperature of 39.5 ^{o}C. The similar rectal temperature of rabbit in K0 and K1 was due to difference the K0 and the K1 cage temperature is not great (1.59 ^{o}C). Thwaites *et al*. (1995) reported that rabbits raised at temperatures of 34 °C had rectal temperature similar to the rabbit maintained at temperature of 36 ^{o}C.

Table 2
Temperature-Humidity Index and Physiological Responses of Rabbits Offered Diets with Different Energy and Protein Content

Variable	Treatment				
	R1	R2	R3	R4	SEM
Cage Temperature (°C)	27.91[a]	27.84[a]	28.01[a]	27.90[a]	0.06
Cage Humidity (%)	74.99[a]	74.79[a]	74.95[a]	74.96[a]	0.09
Temperature-Humidity Index	26.92[a]	26.92[a]	26.99[a]	26.89[a]	0,06
Pulse Rate (times/min)	108.15[b]	107.53[b]	116.18[ab]	125.47[a]	4.23
Rectal Temperature (°C)	39.15[a]	39.16[a]	39.18[a]	39.22[a]	0.08
Skin Temperature (°C)	37.98[a]	37.89 [a]	38.46[a]	38.28[a]	0.25

1) R1: Diet containing 2200 kcalME/kg and 14.00% crude protein
   R2: Diet containing 2400 kcalME/kg and 15.50% crude protein
   R3: Diet containing 2600 kcalME/kg and 17,00% crude protein
   R4: Diet containing 2800 kcalME/kg and 18.50% crude protein
2) The same superscripts in the same row indicate no significant difference (P> 0.05) and different superscripts in the same row indicate significant difference (P <0.05)
3) SEM: Standard Error of the Treatment Means

Diets with different protein and energy content did not affect rectal temperature (Table 2). This indicates that differences in metabolic heat from the difference in energy and protein consumption were not affected rabbit rectal temperature. Mastika (2011) states the fat content in the diets affecting the heat increment or specific dynamic effect that could contribute to lower rectal temperature. The proximate analysis data show that there were not a big difference in crude fat content of the ration in treatments R1 (6.10%), R2 (6.72%), R3 (8.07%) and R4 (10.64%). Perhaps these differences resulting the different the heat increment so that the effect on rectal temperature.

Domestic rabbit skin temperature ranges from 36.26 ° C - 39.97 ° C. Kasa and Thwaites (1993) obtained new zealand white rabbit skin temperature ranges from 34.43 °C - 42.8 °C. Data in Table 1 shows that rabbits skin temperature in K0 is lower than those housed in cage K1. Rabbit in K0 cage has the opportunity to perform homeostatic processes by means of conduction due to the cage floor temperature is lower than the rabbit's body temperature (39.12 C vs. 25.12 ° C). In the

K1 cage, heat conduction process is not so effective because differences of body temperature with cage floor temperature is lower (39.24 C vs. 27.05 ° C). Skin temperature is not affected by diets with different energy and protein levels. Ration of different treatments did not significantly affect the temperature of the cage so that the skin temperature is not too different.

Table 3
Respiration rate of rabbits Offered Different Diets and Housing at Different Cage

Ration	Cage	
	K0	K1
R1	59,26^{b} a	64,63^{a} c
R2	58,40^{b} a	66,46^{a} c
R3	57,93^{b} a	68,75^{a} b
R4	60,61^{b} a	74,52^{a} a

1) K0: Under Ground Shelter Cage
K1: Battery Cage
2) R1: Diet containing 2200 kcalME/kg and 14,00% crude protein
R2: Diet containing 2400 kcalME/kg and 15,50% crude protein
R3: Diet containing 2600 kcalME/kg and 17,00% crude protein
R4: Diet containing 2800 kcalME/kg and 18,50% crude protein
3) The same superscripts in the same row indicate no significant difference ($P > 0.05$) and different superscripts in the same row indicate significant difference ($P < 0.05$)
4) SEM: Standard Error of the Treatment Means

Result of experiments show that domestic rabbit respiration rate 56.60 times /min - 78.75 times/min (Table 3). Bivin and King (1995) reported new zealand white rabbit respiration rate range from 32 times /min - 60 times /min. Esmay (1978); Mahardika (1996); Nuriyasa (2010) reported that the animals respiration rate is an attempt to release body heat by evaporation from the respiratory tract. Lick and Hung (2008) reported that rabbits release body heat by evaporation from the respiratory tract is more effective than the evaporation from the skin surface. At the K0 cage, diets with different energy and protein levels had no effect on respiration rate. At the K0 cage, THI values lower (more comfortable) so that differences in energy and protein content of the ration had no effect on respiration rate. Heat stress at the K1 cage causing energy and protein diets with higher levels, increased respiration rate. De Blas and Wiseman (1998) reported that heat increment from the process of metabolizable energy will increase the heat load in the animals body.

CONCLUSION

Under ground shelter cage had lower temperature-humidity index and gave better physiological responses compared to battery cage. Diets with differing energy and protein level did not affect temperature-humidity index. Diets with 2800 kcalME/kg and 18,50% crude protein gave less physiological impact than those diets containing 2600 kcalME/kg and 17% crude protein, 2400 kcalME/kg and 15,50% crude protein, 2200 kcalME/kg and 14% crude protein.

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