The Effect of Wet Feeding and High Energy to Protein Ratio on Performance of Broilers under Normal and High Temperature Regimes

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Summary
Broiler performance is impaired during heat stress as a result of a reduced feed intake (FI). Previous studies at our lab showed that wet feeding enhanced FI, and that broilers under a high temperature regime preferred a diet with a high energy to protein ratio. The objective of this study was to test the effects of wet feeding and a high energy to protein ratio on performance, heat tolerance and behavior of broilers housed under normal and high temperatures.
Two hundred sixteen one-day-old male broilers were allocated to a normal (NT) and high temperature (HT) regime. Two factors were tested under each temperature regime in a 2x2 design: (1) feed type (normal versus high energy to protein ratio) and (2) feed conformation (wet versus dry). HT and NT were set at 30°C and 20°C (daytime) and 25°C and 18°C (night-time), respectively. Light schedule was 12L:12D.
Overall, FI and BW gain under HT were reduced by 11.8 and 20.7% if compared to NT, with the most pronounced differences in the last two weeks (19.0 and 30.0%). In the same weeks, FCR under NT was improved compared to HT (1.52 and 1.75, respectively). Some interactions on FCR were significant. Body temperature was not affected by dietary treatment but higher in the HT-birds (41.93 versus 41.19°C). Heterophil/lymphocyte ratio (H/L), an indicator of heat stress, was similar among treatments in weeks 1 and 3, but higher under HT in week 6. No effect of feed type or conformation was found for H/L, mainly due to large variances. Foraging behavior was similar among dietary treatments. However, under HT, chickens were more active than under NT. In conclusion, under heat stress, performance and heat tolerance seem to improve if a bird eats a self-selected wet diet, but the effects are small due to excessive needs for energy for panting and locomotion.

Keywords : high temperature, wet feeding, high energy to protein diet, performance

Introduction
Under high ambient temperature (HT), broilers loose body weight due to a reduced feed intake in order to cope with the heat load as associated with heat stress (Dawson and Whittow, 2000; May and Lott, 1992; North and Bell, 1990). For this study, it is questioned whether a wet diet may alleviate the heat load under HT, as has been shown e.g., by Awojobi and co-workers (Awojobi and Meshioye, 2001; Awojobi *et al.*, 2009; Kutlu, 2001). Under normal temperature (NT), it has been shown that wetting a diet improved feed and water intake, body weight gain, and feed conversion efficiency (FCE) of broilers (a.o., Khoa, 2007). Also feeding high moisture pellets to broilers improved FCE significantly (Moritz *et al.*, 2001). Most of the studies mentioned above, however, were performed under NT conditions.
Moreover, in a previous study, broiler chickens preferred to consume larger quantities of the energy (E) components relative to the protein (CP) components from a self-selection ration, in comparison to a standard – practice – diet formulation (Syafwan *et al.*, in prep.).

Therefore in the present experiment, the combined effects of wet versus dry feeding and normal versus high energy to protein ratios under NT and HT conditions on behavior, heat tolerance and performance were tested in broiler chickens.
It is hypothesized that wet feeding an optimal - energy rich - diet reduces body temperature under heat stress conditions (cooling effect of water), thereby increasing feed intake and, as a consequence, BW gain.

Materials and Methods
Two hundred sixteen one-day-old Ross 308 male broilers were allocated to two rooms (NT and HT rooms), 12 pens per room, 9 chickens per pen. Upon arrival, each bird was weighed, wing-tagged and coloured. Each bird had free access to feed and water. Three drinking nipples and one feed trough were placed in each pen. Soft wood shavings covered pen floors (1.75 m W x 1.15 m L and 0.80 m H). Each pen was enriched with two perches. Artificial light schedule was 23-h light and 1-h dark for the first three days. Thereafter, for both NT and HT, a schedule of 12-h continuous light (between 07:30 and 19:30) and 12-h dark (19.30 to 07:30) per day was used to mimic common Indonesian circumstances.
During the first week, temperature inside the room initially was maintained at 32±2°C with a relative humidity (RH) of 70-80%. Thereafter, for the HT treatment, the room was kept at 30±2°C during the day and 25±2°C during the night with RH 70-80%. For the NT treatment, from day 8 to 20, temperature stepped down to 20±2°C during the day and 18±2°C during the night with RH of 40-50%, and maintained as such after day 20. Ventilation rates were equal in all rooms and no daylight entered the house. Two different pellet diets (2 mm) were used: a control diet (CP: 215 g/kg; ME: 12.11 MJ/kg) (NRC, 1994) and an alternative high E to CP diet as derived from the previous experiment (CP: 195 g/kg; ME: 12.83 MJ/kg).
A split plot design was used for statistical analyses. Two temperatures (NT and HT) consisted each of 4 treatment combinations with 2 types of diet (F; control and high E/CP diet) and 2 conformations of the diet (C; wet and dry). Each combination was replicated 3 times.

Results and Discussion
During the entire experimental period, average daily feed intake (FI) and BW gain per bird were 11.8% and 20.7% lower under the HT as compared to the NT regime ($P<0.001$). The differences between HT and NT were especially large in weeks 5 and 6 (19.0 and 30.0%, for FI and BW gain respectively; Table 1).
Birds consumed less feed (12.2%) and grew less (7.2%) when they were fed the high E to CP ratio diet in comparison to the control diet. On average, birds grew significantly faster on a wet diet compared to a dry diet (4.2%; under both temperature regimes). A small interaction between feed type and conformation was significant for BW gain, indicating that for both temperature regimes, wet-fed broilers grew only faster ($P<0.003$) than dry-fed broilers, if they were fed the high E to CP diet (and not if they consumed the control diet).
As a consequence of a low FI and an even lower BW gain under HT conditions, FCR was negatively affected by HT, especially in weeks 5 and 6. Birds housed under NT conditions had better FCR's (on average 1.52) compared to the FCR of bird under HT (on average 1.75) ($P<0.007$) in weeks 5 and 6 (Table 1). Birds that consumed the high E to CP diet had better FCR's (on average 1.61) compared to the FCR's of birds that consumed the control diet (on average 1.66) ($P<0.017$) in weeks 5 and 6. Moreover, wet-fed birds had better FCR's (on average 1.61) compared to the FCR's of dry-fed birds (on average 1.65) ($P<0.022$) in weeks 5 and 6. Interactions existed between T and F or C, due to the fact that these differences were much more pronounced under NT than under HT conditons.
Irrespective of the temperature regime, wet-fed birds on a high E to CP diet show in the last weeks the best FCR (1.54 versus 1.67 in the other 6 groups). This was, however, more

pronounced in the NT-groups. A still relatively high FI of wet-fed birds on a high E to CP diet under HT conditions could point to an excessive need for energy for panting and locomotion, leaving no space for other energy expenses associated with growth. With the control diet, the situation is even worse.

Table 1. Influence of temperature (T; normal versus high), feed type (F; control versus high E to CP diet) and conformation (C; dry versus wet) on feed intake, body weight gain and FCR of male broiler chickens.

Performances	Time	Normal Temperature				High Temperature				Source of variation P value[2]					
		Control		High E to CP diet		Control		High E to CP diet							
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	T	F	C	T*F	T*C	F*C
Feed Intake (g/bird per day)	Week 1-2	28.0	29.4	25.8	24.7	25.6	28.3	24.8	27.0	0.465	**0.006**	**0.048**	0.050	0.065	0.212
	Week 3-4	87.5	95.2	79.2	77.9	88.5	92.5	76.8	82.4	0.966	**0.001**	**0.016**	0.539	0.567	0.190
	Week 5-6	184.4	192.3	166.5	158.0	150.4	148.9	127.1	141.4	**0.002**	**0.002**	0.707	0.066	0.715	0.341
Body Weight Gain (gr/bird per day)	Week 1-2	22.6	25.7	22.3	24.5	24.3	25.1	21.6	23.2	0.693	**0.006**	**0.003**	0.050	0.160	0.939
	Week 3-4	64.6	68.4	57.2	66.0	64.2	64.4	53.2	58.2	**0.034**	**0.003**	**0.007**	0.158	0.161	0.078
	Week 5-6	120.1	120.4	105.7	117.1	87.1	83.9	72.1	82.0	**<0.001**	**0.004**	**0.014**	0.886	0.427	**0.003**
FCR (Feed:body weight gain)	Week 1-2	1.24	1.14	1.15	1.01	1.05	1.12	1.15	1.16	0.374	0.057	**0.031**	**<0.001**	**0.001**	0.121
	Week 3-4	1.36	1.39	1.38	1.18	1.38	1.44	1.45	1.41	0.091	0.074	**0.011**	**0.015**	**0.002**	**<0.001**
	Week 5-6	1.54	1.60	1.58	1.35	1.73	1.79	1.77	1.72	**0.007**	**0.017**	**0.022**	**0.029**	**0.013**	**<0.001**

T is the effect of temperature, F is the effect of feed, C is the effect of conformation, T*F is the interaction between temperature and feed, T*C is the interaction between temperature and conformation and F*C is the interaction between feed and conformation; Significant P-values (*P<0.05*) are depicted in bold

Heterophil/lymphocyte (H/L) ratio, as an indicator of heat stress in the present study, was similar amongst treatments in weeks 1 and 3. In week 6, H/L ratio was found to be higher under HT conditions ($P<0.04$; Table 2). Also, no effect of feed type or conformation was found, mainly due to a large variance.
Body temperature was higher under HT conditions ($P<0.01$) in weeks 1, 3 and 6 (on average, 41.93 vs 41.19°C for HT vs NT, respectively). No effect of feed type and conformation were found (Table 2).
Concerning to chickens behavior, foraging behavior during the experiment was similar among dietary treatments. However, chickens kept under HT conditions were more active (panting, walking, ground pecking, dust bathing and scratching) ($P<0.001$) than under NT conditions (Figure 1), probably due to alleviate heat stress by panting (Shields *et al.*, 2005).

Table 2. Influence of temperature (T; normal versus high), feed type (F; control versus high E to CP diet) and conformation (C; dry versus wet) on HL-ratio and body temperature of male broiler chickens.

Performances	Time	Normal Temperature				High Temperature				Source of variation P value[2]					
		Control		High E to CP diet		Control		High E to CP diet							
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	T	F	C	T*F	T*C	F*C
HL ratio	Week 1	0.09	0.09	0.11	0.10	0.09	0.10	0.10	0.08	0.595	0.532	0.502	0.349	0.900	0.389
	Week 3	0.19	0.18	0.19	0.14	0.22	0.30	0.17	0.25	0.178	0.259	0.110	0.627	**0.005**	0.560
	Week 6	0.20	0.18	0.32	0.28	0.37	0.29	0.27	0.32	**0.040**	0.360	0.610	0.200	0.070	0.310
Tb (°C)	Week 1	41.2	41.4	41.2	41.3	41.3	41.5	41.3	41.3	**0.002**	0.586	0.088	0.930	0.666	0.162
	Week 3	41.2	41.2	41.1	41.3	41.7	42.0	42.0	41.7	**0.022**	0.734	0.756	0.734	0.362	0.105
	Week 6	40.9	41.1	41.2	41.3	42.6	42.7	42.7	42.5	**0.001**	0.370	0.250	0.283	0.250	0.225

T is the effect of temperature, F is the effect of feed, C is the effect of conformation, T*F is the interaction between temperature and feed, T*C is the interaction between temperature and conformation and F*C is the interaction between feed and conformation; Significant P-values (*P<0.05*) are depicted in bold

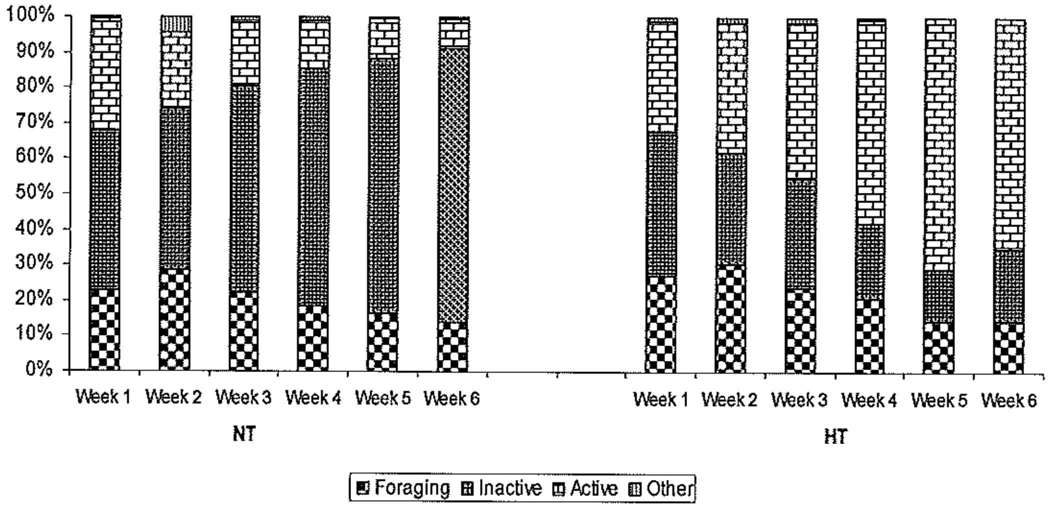

Figure 1. Different aspects of broiler behavior as a percentage of observed behavior under temperature treatments (NT and HT); foraging = eating , drinking ; inactive = standing, preening, perching, lying, resting, sitting, stretching ; active = panting, scratching, ground pecking, walking, dust bathing; other = all other observed behavior not specifically mentioned;

In conclusion, under heat stress, a broiler could benefit from a wet diet with a higher E to CP ratio, but the effect is small due to an excessive need for energy for panting and locomotion, leaving no energy for growth.

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