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Energetics, Mortality, and Body Mass Change of Breeder Chicks Subjected to Different Post-hatch Feed Dosages

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Abstract

Newly hatched leghorn breeder chicks (averaging 38.5 g body mass) housed in shipping containers were subjected to four limited feeding regimens for a three-day (3-d) period. The chicks were then raised for five days with adlibitum access to feed and nipple drinkers. For the 3-d treatment, the chicks received an average of 2.0, 2.5, 3.0, or 3.5 g starter feed (20.5% protein and 12,754 kJ/kg ME) and twice as much Aqua-Jel® (a water supplement) (AJ) placed directly on the honeycomb bedding of the containers. Air temperature at the chick level was maintained at 29.1 ± 0.2°C. Relative humidity was 28 to 37% during the treatment and 31 to 55% during the subsequent growth period. A photoperiod of 12L:12D cycle was provided throughout the experimental period.

The 3-d mortality rate (1.0 to 1.7%) and body mass loss (15.4 to 16.8% initial value) showed no significant difference ($P > 0.05$) among the treatments. Metabolic rate was also not significantly different ($P > 0.05$) among the treatments, although it was generally proportional to the level of nutrient supply. Lighting conditions had a major impact on the chick energetics. Specifically, moisture production (MP) averaged 5.6 to 7.2 g/(kgÿh) during the light period, but 3.8 to 5.1 g/(kgÿh) during the dark period ($P < 0.05$). Total heat production (THP) averaged 8.3 to 9.2 W/kg during the light period and 6.0 to 6.8 W/kg during the dark period. The reduced metabolic rate in the darkness could be a useful avenue for conserving energy and, thus, body mass loss of fasting chicks during prolonged overseas shipment.

The 8-d mortality (2.4 to 3.1%) and the 5-d subsequent body mass gain (42.4 to 45.8% of the initial value) of the chicks also showed no significant difference ($P > 0.05$) among the treatments. Thus a supply of up to 3.5 g feed and 7 g AJ per chick during 72-h post-hatch shipments seems insufficient to achieve a "normal", postshipment chick performance. Energetic responses during the 5-d subsequent growth period were similar for all the treatments. Specifically, THP averaged 21.3 W/kg during the light period and 14.9 W/kg during the dark period ($P < 0.05$). The corresponding MP was 23.6 g/(kgÿh) and 15.0 g/(kgÿh) ($P < 0.05$), respectively.

Keywords

Breeder chicks, Energetics, Mortality, Stress, Transportation

Disciplines

Agriculture | Bioresource and Agricultural Engineering

Comments

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ENERGETICS, MORTALITY, AND BODY MASS CHANGE OF BREEDER CHICKS SUBJECTED TO DIFFERENT POST-HATCH FEED DOSAGES

A. Tanaka, H. Xin

ABSTRACT. *Newly hatched leghorn breeder chicks (averaging 38.5 g body mass) housed in shipping containers were subjected to four limited feeding regimens for a three-day (3-d) period. The chicks were then raised for five days with ad-libitum access to feed and nipple drinkers. For the 3-d treatment, the chicks received an average of 2.0, 2.5, 3.0, or 3.5 g starter feed (20.5% protein and 12,754 kJ/kg ME) and twice as much Aqua-Jel® (a water supplement) (AJ) placed directly on the honeycomb bedding of the containers. Air temperature at the chick level was maintained at 29.1 ± 0.2°C. Relative humidity was 28 to 37% during the treatment and 31 to 55% during the subsequent growth period. A photoperiod of 12L:12D cycle was provided throughout the experimental period.*

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The beneficial effects of supplying nutrients to newly hatched chicks on their subsequent performance (body mass and mortality) have been reported (Pinchasov and Noy, 1993; Stamps and Andrews, 1995; Xin and Lee, 1996). Although the previous studies were based on either an ad-libitum or near maintenance supply of nutrients, chicks in transit generally have limited opportunities to ingest the nutrients. This limitation stems primarily from the lack of adequate in-transit lighting. The time periods when the breeder company can manipulate lighting conditions, thereby enhancing nutrient ingestion for the chicks, are while the chicks are at the hatchery, in the chick bus, and/or at the originating airport. Certain countries such as Japan prohibit import of feed with the chicks because of concerns on microbial contamination of the feed. Meanwhile, certain countries such as Brazil and Ireland have started to require that chicks arrive with a minimal body mass of 35 g (Lohr, 1996, personal communication, Hy-Line International, Dallas Center, Iowa). Hence, data on the effects of limited, pre-air shipment nutrient supplies on chick performance and energetics may help develop guidelines on the nutritional and environmental needs of the chicks and management options to meet such needs.

The objective of this study was to quantify the effects of four post-hatch nutritional regimens on the performance and energetic responses of breeder chicks during a three-day (3-d) post-hatch holding period which emulates the extended shipment duration. The effects of the 3-d nutritional regiments on the subsequent chick performance were evaluated during a 5-d growth period.

MATERIALS AND METHODS

DETERMINATION OF THE NUTRITIONAL REGIMENS

A pre-experimental trial was conducted at the Hy-Line International Production Center, Dallas Center, Iowa. The use of Aqua-Jel (AJ), a water supplement (Transport Containers Corporation, Columbus, Ohio), was measured at 2-h increments for 12 h with the same type of breeder chicks used in the subsequent experiments. The chicks

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Table 1. Cumulative AJ use (g/chick) and body mass (g/chick) of breeder chicks vs time of exposure, mean (μ), and standard error (SE)

Response Variable		Duration of Exposure (h) 0	2	4	6	8	10	12
Cumulative AJ use (g/chick)	μ	0.0	2.1	4.2	5.2	6.0	6.5	7.0
	SE	0.0	0.2	0.0	0.1	0.0	0.0	0.0
Chick body mass (g/chick)	μ	38.6	40.8	41.6	42.0	41.8	41.7	41.6
	SE	0.1	0.2	0.3	0.2	0.1	0.2	0.2

were housed in two, four-compartment shipping containers (61 L × 46 W × 18 H cm), 22 chicks per compartment. Each compartment was provided with 300 g of AJ and 150 g of starter feed (20.5% protein and 12,754 kJ/kg ME) on a honeycomb bedding. Because of the method in feed supply, feed use was not measured, but assumed to be half of the AJ use based on the previous experimental result by Xin and Lee (1996). Air temperature at the chick level averaged 27.8 ± 0.1°C, and relative humidity (RH) was 60 ± 1%. The cumulative AJ use and body mass of the chicks over the first 12-h exposure period are listed in table 1. The nutritional regimens of 4.0/2.0 (g AJ/g feed per chick), 5.0/2.5, 6.0/3.0, and 7.0/3.5 were chosen for further extensive evaluation. The intake levels approximately corresponded to those for the exposure period of 4, 6, 8, and 12 h, respectively.

Evaluation of the Nutritional Regimens

Within five hours after hatching, the experimental breeder chicks in 16 commercial shipping containers (88 chicks each) were delivered from the hatchery of Hy-Line International Production Center located 50 km away to our Livestock Environment and Physiology (LEAP) Research Laboratory at Iowa State University in Ames. Upon arrival, the chicks were weighed and provided with the respective nutritional regimens of 4.0/2.0, 5.0/2.5, 6.0/3.0, and 7.0/3.5 g AJ/g feed per chick. The chick containers were then randomly assigned, by nutritional regimen, to four environmentally controlled calorimeter chambers (four containers per chamber), where they were evenly spaced on a suspended wood shavings floor.

The original cardboard container lids were replaced with poultry-netting lids to ensure proper air exchange between the chicks and the chamber environment. This step was necessary to obtain realistic representation of the air composition and proper control of the environment surrounding the chicks. Air temperature at the chick level was maintained at the thermoneutral level of 29.1 ± 0.2°C with a RH of 28 to 37%. Although air temperature during the actual shipments is generally cyclic (Xin and Rieger, 1995), the thermoneutral constant temperature was used to evaluate the efficacy of the nutritional regimens without introducing a potential covariant. Furthermore, a study performed by Xin (1997) that examined the effects of simulated in-transit temperature fluctuations on chicks revealed that the group-housed chicks can tolerate temperature fluctuations of up to 16.7°C (± 8.3°C) when the mean temperature is at the thermoneutral level of 29°C. Uniform fluorescent lighting of 26 lux (2.5 fc) illumination was programmed to cycle at 12 h on and 12 h off (12L:12D). While the lighting scheme would not be typical of the current shipment operation, work has been underway to quantify and meet the in-transit lighting needs by the chicks (Han, 1997). The treatments lasted for three days. The chicks were then raised on wood shavings floor with ad-libitum access to feed and nipple drinkers for five days. The environment and lighting program during the 5-d growth period were the same as during the 3-d treatment period except for a higher RH of 31 to 55%.

Mortality and morbidity were monitored and recorded daily throughout the trial period. Body mass was measured at the beginning of the trial, at the end of the 3-d treatment, and again at the end of the 5-d subsequent growth period. Body mass was assumed to change linearly between the weighing points in converting heat and moisture production rate to unit body mass base.

Total heat production rate (THP,W/kg) was measured, at 30-min intervals, by using indirect calorimetry (i.e., based on O_2 consumption and CO_2 production rate of the chicks). Moisture production rate [MP, g/(kg(h)] was inclusive of all the water sources of the environment. Sensible heat production (SHP, W/kg) was calculated as the difference between THP and the MP-based latent heat production. The energetic responses were further partitioned into light or dark period. A detailed description of the ISU calorimeter system and its operation can be found elsewhere (Xin and Harmon, 1996). The equations used in calculation of the energetic responses are as follows.

Total Heat Production Rate (THP, W/kg)

$$THP = 16.18 O_2 + 5.02 CO_2 \quad \text{(Brouwer, 1965)} \qquad (1)$$

where O_2 is the oxygen consumption rate of the chicks ($mL \cdot s^{-1} \cdot kg^{-1}$), STPD; and CO_2 is the carbon dioxide production rate of the chicks, ($mL \cdot s^{-1} \cdot kg^{-1}$), STPD:

$$O_2 = V_i (X_i - \alpha X_o) \cdot 10^{-6} \qquad (2)$$

$$CO_2 = V_i (\alpha Y_o - Y_i) \cdot 10^{-6} \qquad (3)$$

where

- V_i = inlet airflow rate ($ml \cdot s^{-1} \cdot kg^{-1}$), STPD
- X_i, X_o = oxygen concentration of the inlet and outlet air, respectively (ppm)
- Y_i, Y_o = carbon dioxide concentration of the inlet and outlet air, respectively (ppm)
- α = correction factor for the outlet airflow rate

$$\alpha = \frac{V_o}{V_i} = \frac{1 - (X_i + Y_i) \times 10^{-6}}{1 - (X_o + Y_o) \times 10^{-6}} \qquad (4)$$

Moisture Production Rate (MP, g H_2O/[h(kg])

$$MP = V_i \times \rho(\alpha W_o - W_i) \times \frac{3600}{1000} \qquad (5)$$

where ρ is the density of air, 1.293 $g \cdot L^{-1}$; W_i ,W_o is the humidity ratio of the inlet and outlet air, respectively ($gH_2O \cdot gDA^{-1}$).

$$W = 0.62198 \left(\frac{P_w}{P - P_w} \right) \quad \text{(Weiss, 1977)} \tag{6}$$

where P is the barometric pressure of ambient air (kPa); and P_w is the partial vapor pressure of the inlet or outlet air (kPa), calculated as:

$$P_w = 0.61078\, e^{\left(\frac{17.2693882\, t_p}{t_{dp} + 237.30} \right)} \quad \text{(Weiss, 1977)} \tag{7}$$

where t_{dp} represents dew point temperature of the inlet or outlet air (°C).

Sensible Heat Production (SHP, W/kg)

$$SHP = THP - MP \cdot h_{fg} \cdot 3600^{-1} \tag{8}$$

where h_{fg} is latent heat of water vaporization, 2450 $J \cdot K^{-1} \cdot g^{-1}$.

Respiratory Quotient (RQ)

$$RQ = \frac{CO_2}{O_2} \tag{9}$$

Each nutritional regimen was replicated four times by using a complete randomized block design. Analysis of variance and Duncan's multiple range mean comparison were performed to evaluate the treatment effects.

Results and Discussion

Body Mass Change and Mortality

Body mass change and cumulative mortality rates of the chicks during the treatment and subsequent growth periods are summarized in table 2. The 3-d treatment period led to a significant ($P < 0.05$) body mass loss (BML) for all the regimens, averaging 16.4, 16.8, 15.6, and 15.4% of the initial body mass (IBM), respectively. The 5-d subsequent growth brought a body mass gain of 42.4, 43.3, 45.2, and 45.8% of IBM, respectively. No significant difference in body mass ($P > 0.05$) was detected among the regimens during either period, although the eighth body mass numerically reflected the level of the initial nutrient supply. Compared with the 20% BML when no nutrient supply was available for 72 h (Xin and Lee, 1996), the lower BMLs observed in this study demonstrated the positive effects of the nutrient supply in alleviating BML. Nevertheless, as mentioned earlier certain countries (e.g., Brazil and Ireland) have started requiring that breeder chicks arrive at their destination with a body mass of not less than 35 g. This means that BML should be controlled within 9% IBM (i.e., IBM = 38.5 g). The BML of this study might have been lowered by keeping the chicks in continuous darkness after the first 12-h light exposure when the supplied nutrients had been consumed. This is because complete darkness would have reduced the activity-related metabolic rate (as shown below) and, thus, help the chicks conserve body energy. Interestingly, the present BML paralleled that (14.9%) of fasting chicks for 50 h under continuous light and 30°C (Xin and Harmon, 1996).

There was no significant difference ($P > 0.05$) in chick mortality rate among the regimens at the end of 3-d treatment or the 8-d trial period, although the greater quantities of nutrient supply tended to result in a numerically lower mortality. The magnitude of the 8-d cumulative mortality in this study (2.9, 3.1, 2.4, and 2.6%) was much lower than the 8-d mortality level (20.3%) without a nutrient supply for 72 h (Xin and Lee, 1996) but considerably higher than when a greater amount of nutrient (i.e., 10 g feed and 15 g AJ) was provided (1.3%) (Xin and Lee, 1996). A diet with higher energy content might be beneficial (provided the same feed intake by the chicks) in reducing BML and should be investigated in future studies.

Energetic Responses

The average energetic responses for both the treatment and growth periods are listed in tables 3 and 4. THP during the dark period were 25 to 29% lower ($P < 0.05$) than that during the light period, presumably resulting from reduced chick activities. Xin et al. (1996) also noted a similar effect of darkness on THP for broiler chickens. The reduced metabolic rate in darkness could be an effective avenue to conserve body energy and thus BML of the chicks during extended shipments. This statement is of course under the premise of no additional supply of feed or equivalent nutrients. THP during the light period for the present nutritional regimens

Table 2. Body mass and cumulative mortality of breeder chicks as influenced by 3-d, post-hatch nutritional treatments (mean, μ, and standard error, SE)

AJ/Feed Dosage (g/chick)		Body Mass (g/chick)			Cumulative Mortality (% Placement): Treatment Period			Cumulative Mortality (% Placement): Growth Period				
		Day 1*	Day 4†	Day 8‡	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
4.0/2.0	μ	38.4^{b}_{1}	32.1^{c}_{1}	54.7^{a}_{1}	0.2^{b}_{12}	0.7^{ab}_{1}	1.0^{a}_{1}	1.8^{a}_{1}	2.8^{a}_{1}	2.9^{a}_{1}	2.9^{a}_{1}	2.9^{a}_{1}
	SE	0.2	0.2	0.2	0.1	0.2	0.2	0.5	0.5	0.5	0.5	0.5
5.0/2.5	μ	38.6^{b}_{1}	32.1^{c}_{1}	55.3^{a}_{1}	0.8^{a}_{2}	0.9^{a}_{1}	1.7^{a}_{1}	2.2^{a}_{1}	2.8^{a}_{1}	3.0^{a}_{1}	3.1^{a}_{1}	3.1^{a}_{1}
	SE	0.3	0.1	1.1	0.4	0.4	0.4	0.4	0.6	0.5	0.5	0.5
6.0/3.0	μ	38.5^{b}_{1}	32.5^{c}_{1}	55.9^{a}_{1}	0.3^{b}_{12}	0.6^{ab}_{1}	1.0^{a}_{1}	1.4^{a}_{1}	2.3^{a}_{1}	2.4^{a}_{1}	2.4^{a}_{1}	2.4^{a}_{1}
	SE	0.3	0.3	0.4	0.2	0.2	0.2	0.1	0.4	0.4	0.4	0.4
7.0/3.5	μ	38.4^{b}_{1}	32.5^{c}_{1}	56.0^{a}_{1}	0.0^{b}_{1}	0.4^{b}_{1}	1.0^{a}_{1}	1.5^{a}_{1}	2.3^{a}_{1}	2.5^{a}_{1}	2.6^{a}_{1}	2.6^{a}_{1}
	SE	0.2	0.3	0.3	0.0	0.2	0.2	0.3	0.4	0.4	0.4	0.4

* Beginning of trial.
† End of 3-d treatment.
‡ End of 5-d growth period.
NOTE: Column means with the same subscript numbers are not significantly different ($P > 0.05$). Row means with the same superscript letters are not significantly different ($P > 0.05$).

Table 3. Total heat production (THP) and respiratory quotient (RQ) of breeder chicks during a 3-d nutritional treatment and 5-d growth period (mean, μ, and standard error, SE)

Period	L/D*		THP (W/kg)				RQ (-)			
			4.0/2.0†	5.0/2.5	6.0/3.0	7.0/3.5	4.0/2.0	5.0/2.5	6.0/3.0	7.0/3.5
Treat.	L	μ	8.4^{a}_{1}	8.3^{a}_{1}	9.0^{a}_{1}	9.2^{a}_{1}	0.81^{a}_{1}	0.81^{a}_{1}	0.79^{a}_{1}	0.84^{a}_{1}
		SE	0.4	0.3	0.5	0.3	0.03	0.02	0.02	0.01
	D	μ	6.0^{a}_{2}	6.0^{a}_{2}	6.8^{a}_{2}	6.7^{a}_{2}	0.85^{a}_{1}	0.85^{a}_{1}	0.84^{a}_{1}	0.90^{a}_{1}
		SE	0.3	0.1	0.5	0.3	0.02	0.01	0.04	0.05
	Avg.	μ	7.2^{a}	7.2^{a}	7.9^{a}	8.0^{a}	0.83^{a}	0.83^{a}	0.82^{a}	0.87^{a}
		SE	0.3	0.2	0.5	0.3	0.02	0.01	0.01	0.03
Growth	L	μ	20.4^{a}_{1}	20.7^{a}_{1}	21.4^{a}_{1}	22.5^{a}_{1}	0.90^{a}_{1}	0.88^{a}_{1}	0.88^{a}_{1}	0.89^{a}_{1}
		SE	0.7	0.3	1.2	0.3	0.04	0.04	0.03	0.03
	D	μ	14.3^{a}_{2}	15.2^{a}_{2}	15.0^{a}_{1}	14.9^{a}_{2}	0.91^{a}_{1}	0.93^{a}_{1}	0.94^{a}_{1}	1.00^{a}_{1}
		SE	0.8	0.9	2.0	1.4	0.02	0.04	0.04	0.05
	Avg.	μ	17.4^{a}	18.0^{a}	18.2^{a}	18.7^{a}	0.90^{a}	0.90^{a}	0.91^{a}	0.94^{a}
		SE	0.7	0.6	1.6	0.8	0.02	0.03	0.02	0.02

* L/D = lighting condition of light (L) or dark (D).
† Average AJ/Feed per chick.
NOTE: Column means with the same subscript numbers are not significantly different (P > 0.05). Row means with the same superscript letters are not significantly different (P > 0.05).

Table 4. Moisture production (MP) and sensible heat production (SHP) of breeder chicks during a 3-d nutritional treatment and 5-d growth period (mean, μ, and standard error, SE)

Period	L/D*		MP (g/kg-h)				SHP (W/kg)			
			4.0/2.0†	5.0/2.5	6.0/3.0	7.0/3.5	4.0/2.0	5.0/2.5	6.0/3.0	7.0/3.5
Treat.	L	μ	5.6^{c}_{1}	6.1^{bc}_{1}	6.8^{ab}_{1}	7.2^{a}_{1}	4.6^{a}_{1}	4.1^{a}_{1}	4.4^{a}_{1}	4.3^{a}_{1}
		SE	0.2	0.3	0.3	0.4	0.3	0.3	0.3	0.2
	D	μ	3.8^{b}_{2}	4.3^{ab}_{2}	4.6^{ab}_{2}	5.1^{a}_{2}	3.4^{a}_{2}	3.1^{a}_{1}	3.7^{a}_{1}	3.3^{a}_{2}
		SE	0.1	0.2	0.3	0.4	0.2	0.2	0.4	0.3
	Avg.	μ	4.7^{b}	5.2^{ab}	5.7^{ab}	6.2^{a}	4.0^{a}	3.6^{a}	4.0^{a}	3.8^{a}
		SE	0.1	0.3	0.3	0.4	0.2	0.3	0.4	0.3
Growth	L	μ	22.9^{a}_{1}	22.8^{a}_{1}	23.8^{a}_{1}	24.8^{a}_{1}	4.8^{a}_{1}	5.3^{a}_{1}	5.2^{a}_{1}	5.7^{a}_{1}
		SE	0.9	1.0	1.5	0.4	0.4	0.7	0.4	0.4
	D	μ	14.7^{a}_{2}	15.4^{a}_{2}	14.9^{a}_{2}	15.0^{a}_{2}	4.4^{a}_{1}	4.7^{a}_{1}	4.9^{a}_{1}	4.8^{a}_{1}
		SE	0.8	1.2	1.7	0.7	0.3	0.1	0.8	1.0
	Avg.	μ	18.8^{a}	19.1^{a}	19.3^{a}	19.9^{a}	4.6^{a}	5.0^{a}	5.1^{a}	5.2^{a}
		SE	0.7	0.9	1.5	0.5	0.3	0.4	0.6	0.6

* L/D = lighting condition of light (L) or dark (D).
† Average AJ/Feed per chick.
NOTE: Column means with the same subscript numbers are not significantly different (P > 0.05). Row means with the same superscript letters are not significantly different (P > 0.05).

(8.4 to 9.2 W/kg) was considerably lower than the THP (11.1 W/kg) of chicks supplied with the higher amount of feed (10 g/chick) and AJ (15 g/chick) as measured by Han and Xin (1997). However, average THP for the 6.0/3.0 and 7.0/3.5 treatments (9.0 and 9.2 W/kg) was higher than the average THP of chicks (8.5 W/kg) during a 50-h posthatch fasting (Xin and Harmon, 1996). The RQ among the nutritional regiments was not significantly different (P > 0.05), although RQ tended to be higher for the largest dosage (7.0/3.5). The 3-d average RQ values of the present study (0.81 to 0.90) were considerably higher than the 2-d average RQ (0.74-0.75) of fasting chicks observed by Xin and Harmon (1996). The results suggest that the supply of nutrient (feed and AJ in this case) could have reduced the relative contribution of the endogenous absorption of the residual yolk. A similar result had been reported by Nitsan et al. (1995) for chicks intubated with soybean oil.

As expected, MP was proportional to the amount of AJ supply (table 4), and was much higher than MP [4.1 g/(kg·h)] for the fasting chicks (Xin and Harmon, 1996). SHP of the present study (4.1 to 4.6 W/kg during the light period) was lower than SHP for the fasting chicks (5.7 W/kg) at 30°C (Xin and Harmon, 1996). The lower SHP value of this study could have been attributed to its use for evaporating moisture of AJ. The MP and SHP of this study took into account both the chicks and their environment (i.e., evaporation of feces and AJ). Thus, they provide a more realistic database for design and operation of the in-transit ventilation system compared with the data based on the chicks' energetics only.

The average THP during the 5-d subsequent growth period was not significantly ($P > 0.05$) affected by the 3-d prior nutritional regimens, although it was numerically proportional to the level of nutrient supply. THP during the dark period was 27 to 34% lower than the THP during the light period ($P < 0.05$). THP of 20.4 to 22.5 W/kg of this study during the light period was somewhat higher than the THP of 18.3 W/kg for broilers at the same age and brooding environment (29.4°C) (Reece and Lott, 1982). The difference could have been attributed to the fact that THP of the present study corresponded to a 12-h daytime light period; whereas the THP by Reece and Lott was for 24-h light period which would include the lower nocturnal THP of the chicks. The average THP of both light and dark periods (18.8 to 19.9 W/kg) for the present study was much closer to the 24-h THP value of Reece and Lott.

MP during the subsequent 5-d growth period, 22.9 to 24.9 g/(kg·h) for the light period and 18.8 to 19.9 g/(kg·h) for both the light and dark periods combined, was in fair agreement with the literature value of 22.0 g/(kg·h) (Reece and Lott, 1982). SHP of the present study (4.4 to 5.7 W/kg) was somewhat higher than the literature value of 4.2 W/kg, especially during the light period (table 4). Note, however, that the partition of THP into MP and SHP is subject to the influence of many housing and management factors such as housing type (floor vs cage), litter condition, drinking system, heating method (gas, electric, or water), and moisture content of the air.

Conclusions

The following conclusions were drawn from this study:

1. Breeder chicks supplied with 2.0 to 3.5 g feed and 4.0 to 7.0 g AJ water supplement per chick during a 3-d post-hatch holding period showed a 15.4 to 16.8% body mass reduction that did not significantly differ among the nutritional regimens.
2. The breeder chicks had an early (8-d) mortality rate of 2.4 to 3.1% that also did not significantly differ among the 3-d, prior nutritional regimens.
3. "In-transit" supply of up to 3.5 g feed seems insufficient to achieve a satisfactory chick body mass maintenance and subsequent early livability.
4. Energetic responses of the chicks did not significantly differ among the nutritional regimens; however, lighting conditions had a significant impact on the metabolic rate of the chicks and might be used to help the fasting chicks conserve body energy during transportation.

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