Water consumption pattern of laying hens under hot humid conditions

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Abstract

Objective of the present study was to understand the water consumption pattern of laying hens under hot-humid conditions. Seventeen-week old layer pullets (n=25) were randomly allocated to 5 cages. Each cage had a feeder and a drinker. Daily feed and water intake and, the egg production were recorded from 18th to 26th week. The laying cycle commenced when birds were 19 weeks old. The mean body weight of the birds at the commencement of the laying cycle was 1235 g. Laying hens consumed more water during day time than night time. The day time water intake doubled from 72 ml to 145 ml/day/bird from 18th week to 26th week. The night time water intake increased slowly from 72 ml at 18th week to 89 ml at 26th week. The total water intake of non-laying pullets significantly increased (p<0.01) from 147 ml/bird/day to 176 ml/bird/day during the first week of laying cycle. The intake of water gradually increased up to 234 ml/day when birds were 26 weesk old. The intake of water increased non-significantly from week 20-25. Water: feed ratio of the pullets was 1.4 and increased non significantly to 1.5 during the first week of the laying cycle. Then the water: feed ratio increased gradually up to 23rd week (2.0) and then declined to 1.2 at 26th week. Non laying pullets drank 12.6 ml of water/100 g of body weight. Water consumption per unit body weight increased as laying cycle progressed and reached a maximum (16.7ml/100 g body weight) at 26th week. During the first week of laying cycle (19th week), birds drank 4.4 ml/g of egg produced. The consumption of water per unit of egg increased significantly during the second week of the cycle (4.9 ml/g of egg) and then declined to maintain at a constant level around 4.4 ml during the rest of the study period. The daily water requirement (ml/day/bird) of a laying hen could be expressed as 152.5 + 0.2 X; (R^2=0.59) where x is the sum of live weight and egg weight.

Key words: pullets, layers, water intake, water: feed ratio

Introduction

Even though specific requirements have not been set, water can reasonably be regarded as an essential nutrient for all classes of livestock. Documented water intake data for laying hens are limited (NRC, 1994). The amount of water depend on environmental and dietary factors, rate of production and efficiency of kidney water resorption in individual birds (NRC 1994), physiological stage (Leeson and Summers, 1987), the type of the drinker (Dunn and Emmans, 1971 as cited by NRC, 1994) and the number of birds per drinker (Garnet and Adams, 1992). Consequently, except on a few occasions, birds are given water *ad libitum*. Water is primarily required for bodily maintenance activities and then for production. An average egg contains 66.7 % water (McDonald et al. 1995) and thus approximately 39 ml of water is exported with each egg produced. Therefore the transition from non-laying pullets to laying stage is associated with increased metabolic activities and water demand. We were unable to find any literature pertaining to the water consumption pattern of pullets and laying hens in the early stages of the laying cycle, under hot-humid conditions.

The present experiment was conducted to study how the water consumption pattern changes as pullets enter into laying cycle and, during the early stages of the laying cycle, under hot-humid conditions.

Materials and methods

Seventeen-week old layer pullets (n=25) were allocated to five deep litter cages so that between cage weight variation is minimum. Paddy husk was used as the litter material. Each pullet was given 3 ft^2 of floor space. Each cage had a feeder and a bell-shaped drinker. Birds were acclimatized to the pens for one week before the commencement of data collection. Birds were fed with on-farm prepared mash diets (Table 1).

Table 1. Composition of the grower and layer diets and the calculated nutrient composition

Ingredient (%)	Grower Ration	Finisher Ration
Yellow maize meal	12	10.0
Rice polish	46.5	47.0
Broken rice	15	12.0
Coconut oil meal	9	3..5
Soybean oil meal	10	130
Gingelly oil meal	0	3.5
Fish (local)	3	0.5
Meat and bone meal	2	2.8
Salt	0.25	0.25
Shell grit	1	
Shell powder	0	7.0
Four F twin pack	0	0.15
Dical PO4	0.7	
Antioxident	0.0125	
DL Methionine	0.12	0.12
L Lysine	0.01	0.025
Premix (0.2)	0.02	
Enermax (0.01)	0.01	
Aflatoxin Binder (0.05)	0.05	
Nutrient Composition (Calculated)		
CP %	16.08	15.3
CF %	5.44	6.2
Energy kcal/kg	2883.08	2736
Ca	0.93	3.3
Non phytate phosphorus	0.46	0.43
Lysine	0.35	0.78
Met+Cys	0.67	0.67

The cage-wise daily feed and water intake and egg production were recorded from week 18 to 26. Shell grit was introduced at 21st week and birds were given *ad libitum* access to water, feed and shell grit. Natural photoshedule was maintained. Data were analyzed using GLM procedure of the SAS (1989).

Results and discussion

Commencement of the laying cycle

The laying cycle commenced when birds were 19 weeks old and at mean live weight of 1235±51g. 19 week old birds at the first week of the laying cycle were significantly heavier than the 18-weeks old pullets. Birds of the original flock from which the experimental subjects were selected also commenced the laying cycle at the 19th week.

Water intake or water disappearance?

In this experiment, water intake was measured as the difference between the water offered (given in bell-shaped drinker) and water left over. Though utmost care was taken to minimize the water spillage, occasionally we found that birds had spilled water and, on such occasions, the intake of water of that drinker was omitted from the calculations. Since we did not measure the evaporation losses from the drinkers, the intake values might have been over estimated due to evaporation losses. Water intake measurements conducted with nipple drinkers were reported to be lower than the intake values taken with open devices such as bell-drinkers and troughs. For example, Dun and Emmans (1971) as cited by NRC (1994) compared the water intake of hens on trough and nipple watering system and found that birds "consumed" 166 ml and 254 ml per day in nipple and trough system, respectively. Since we did not measure the water spillage and evaporation losses, the intake values we report herein may best be interpreted as the "water disappearance". However, since spillage of water from the commonly used bell-shaped drinkers and evaporation is inevitable under normal farming conditions, the following discussion uses the term water intake instead of the technically more correct water disappearance.

Water intake measurements

The pattern of water and feed intake of pullets at 18th week and layers up to 26th week are shown in Table 2. Eighteen weeks old pullets drank similar amount of water during day time and night time. However, layers at the first week of the laying cycle drank significantly more water during day time than during night time. Interestingly, the day time water intake of non laying pullets increased significantly ($p<0.001$) from 73 ml to 105 ml with the commencement of the laying cycle. The day time water intake doubled from 72 ml to 145 ml/day/bird from 18th week to 26th week, whereas the night time water intake increased quite slowly from 74 at 18th week to 89 ml at 26th week. Mongin and Sauveur (1974) found that water consumption peaked just after the ovipiosition and during the albumin deposition. Hence, high water demand during day time can best be related to the egg formation physiology. The finding that there was no significant difference between the day time and night time water intake in pullets at 18th week further supports the above hypothesis. However it must be noted that we measured the feed and water intake at 0830 and 1630hrs of the day and did not provide lights during night.

The total water intake of pullets significantly increased ($p<0.001$) from 147 ml/birds/day to 176 ml/bird/day when they were at the first week of the laying cycle. Anderson and Hill (1967) also found a significant increase in water intake with the onset of the laying cycle. Lumijarva and Hill, 1968; as cited by Leeson and Summers (1987) concluded that increased water intake with sexual maturity was related to hormonal balance. Intake of water gradually increased up to 234 ml/day when birds were 26 week old. The intake of water increased, though not significant as laying cycle progressed through week 20 to 25.

Both the daytime and night time feed intake changed slightly as birds proceeded through the laying cycle. Compared to water intake, the day time feed intake of the non laying pullets did not increase significantly with the commencement of the laying cycle. During the first six weeks of the cycle, the day time feed intake increased gradually, but not significantly. But by the seventh week of the laying cycle, the intake doubled and the intake during the seventh and eighth weeks were significantly higher than earlier weeks. Similar to night time water intake, the night time feed intake also changed slightly.

The total daily feed intake of non laying pullets did not increase significantly with the commencement of the laying cycle. The total feed intakes during seventh and eighth weeks of the cycle were significantly higher ($p<0.001$) than in the pullets and layers up to sixth week of the cycle. Pattern of the water and feed intake suggests that with the commencement of the laying cycle, the intake of water increases sharply but the intake of feed increases smoothly as the laying cycle proceeds. However, both the intake of water and feed increased by about 60% when layers are 26 week old (at the seventh week of the laying cycle), compared to non laying pullets.

Compared to water and feed intake values, the water: feed ratio did not show a clear pattern. The water: feed ratio ranged from 1.1 to 2 (mean 1.5). Water: feed ratio of the pullets; 1.4 and increased non significantly to 1.5 during the first week of the laying cycle. Then the water: feed ratio increased gradually up to 23rd week (2.0) and then declined to 1.2 at 26th week. Gernat and Adams (1992) reported a water: feed ratio of 1.7 for layers on nipple drinkers. Pullets drank 12.6 ml of water per 100 g of body weight. Water consumption per unit body weight increased as the laying cycle progressed and reached a maximum of 16.7ml/100 g body weight at 26th week. Our findings, in general are in agreement with the findings of Medway and Kare (1959; as cited by Leeson and Summesr, 1987). They found that the water intake per 100 g of body weight decreases from 45 ml at 7 days to 13 ml at 16th week, subsequently increasing to 24 ml at full maturity. The water consumption of layers per unit body weight was low compared to that of broiler chickens kept at the same environmental conditions. For example, Lal and Atapatu, (2006) and Atapattu and Gamage (2006) have reported that broiler chicks around 1600 g drink around 35-40 ml of water per 100 g of body weight. Higher metabolic rate and feed intake of the broilers, compared to layers may probably be the reason for that difference. During the first week of the laying cycle (19th week) birds drank 4.4 ml/g of egg produced. The consumption of water per unit of egg increased significantly during the second week of the cycle (4.9 ml/g of egg) and then declined to maintain at a constant level around 4.4 during the rest of the study period.

The percentage of water exported with egg was calculated (Table 3) and, found that it varied within a narrow range from 12% to 15% of the total intake. However, a somewhat lower contribution (10%) has been reported by Tylor (1958). Computation of the data showed that the actual metabolic water requirement for egg formation exceeds the amount of water exported with egg (Table 3). The metabolic water requirement for egg formation is defined as the difference between the total water requirement and the water exported as egg. Except in the first week of the laying cycle, the metabolic water requirements for egg formation are higher than the water exported with egg in respective weeks. Chapman and Mihai (1972) as cited by Leeson and Summers (1987) also found that water intake of laying vs non laying birds was much higher than that can be accounted for by egg formation alone. Hill et al (1979) found that drinking of water by poultry was followed by meals. Therefore the additional amount of water requirement may be related to the increased feed intake.

1. Body weight *12, 61.100
2. Tool requirement – maintenance requirement *100
3. Intake for egg production total intake *100
4. Assuming water % of egg is 66.7% (McDonald et al 1995)
5. Water exported with egg/total water intake *100
6. Water exported with egg /water intake for egg production *100

The daily water requirement (ml/day/bird) of a laying hen could be expressed as 152.5 + 0.2 X; (R^2=0.59) where x is the sum of live weight and egg weight. It was concluded that water intake of pullets increased significantly with the commencement of the laying cycle and 10 -15 % of the total water consumed is exported with eggs. Furthermore, it was concluded that the actual metabolic water requirement for egg production is higher than the water exported with eggs.

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Table 2. Water and Feed intake pattern of pullets and layers at the early stages of the laying cycle.

Feature	Week 18	Week 19	Week 20	Week 22	Week 23	Week 24	Week 25	Week 26	Level of Significance
Body Weight	1170± 13.7^{f}	1235.2± 51.4^{e}	1284.2± 48.6^{d}	1306.4± 5.8^{cd}	1320± 46.9^{bcd}	1338.2± 12.79^{bc}	1359.6±12.9^{a}	1402.8± 55.09^{a}	0.0001
Feed Intake									
Day Time	72.8±34.26^{b}	68.4± 17.04^{b}	72.4± 7.3^{b}	72.6± 34.2	72.51 ±17.78^{b}	86.51± 10.13^{b}	131.2 ±37.3^{a}	128.9± 43.3^{a}	0.0001
Night Time	52.2 ±28.7^{bac}	52.8± 20.2^{bac}	48.0± 8.1^{bc}	42.2± 6.9^{c}	46.6± 9.6^{bc}	46.4± 11.7^{bc}	67.3± 17.8^{ba}	72.2 ±17.6^{a}	0.0576
Total	125.1± 60.7^{b}	121.2± 34.9^{b}	120.5 ±14^{b}	114.8± 37.9^{b}	119.1± 24^{b}	132.9± 21^{b}	198.5± 52.6^{a}	201.2±52.7^{a}	0.0001
Water Intake									
Day Time	73.2 ±5.8^{d}	105.7 ±11.2^{bc}	126.4 ±5.1^{bc}	124.4 ±15.6^{dc}	113.7± 12.8^{bc}	125.6± 16.3^{ab}	134.9 ±14.1^{a}	145± 10.3	0.0001
Night Time	74.3±14.2^{bc}	70.5± 6.3^{c}	74.8± 11.2^{bc}	93 ±17.7^{ab}	96.6± 14.3^{a}	80.5± 21.7^{abc}	84.8± 14.2^{abc}	89.4± 6.6^{abc}	0.0210
Total	147.6± 14.2^{d}	176.2± 12.6^{c}	201.3 ±14.4^{b}	217.4± 22.5^{ba}	210.3 ±23.9^{ba}	206.13± 33.65^{b}	219.7± 7.1^{ba}	234.5± 6.8^{a}	0.0001
Water : Feed Ratio	1.4± 0.7^{bc}	1.5± 0.3^{bac}	1.69 ±0.28^{bac}	2.0± 0.5^{a}	1.8 ±0.6^{ba}	1.5± 0.3^{bac}	1.18 ±0.34^{c}	1.2± 0.3^{c}	0.0039
Total Water Intake/100 Body Weight	12.6± 1.2^{c}	14.3± 1.5^{bc}	15.7± 1.3^{ba}	16.6± 1.7^{a}	15.9± 1.9^{ba}	15.4± 2.5^{ba}	16.1± 0.6^{ba}	16.7± 0.5^{a}	0.0023
Egg Weight		39.5± 2.1^{d}	40.6± 2.2^{d}	46.5± 1.9^{c}	48.2± 1.6^{bac}	47.6± 1.0^{bc}	50.1± 1.4^{a}	49.3± 1.6^{ba}	0.0001
Total Water Intake/Egg Weight		4.47± 0.4^{ba}	4.9± 0.4^{a}	4.7± 0.6^{ba}	4.3± 0.4^{b}	4.3 ±0.7^{b}	4.3± 0.1^{ba}	4.7± 0.2^{ba}	0.0518

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Table 3. Conversion efficiency if water consumed into egg water

Week	18	19	20	22	23	24	25	26
Total Water Intake (ml)	147.6± 14.20	176.23±12.64	201.33±14.45	217.4±22.53	210.34±23.97	206.13±33.65	219.77±7.19	234.51±6.89
Body Weight (g)	1170	1235.2±51.41	1284.2±48.65	1306.4±5.86	1320±46.95	1333.2±12.77	1359.6±12.99	1402.8±55.09
Intake for Maintenance[1]	147	155	162	164	166	168	171	176
Intake for egg Production[2]	0	21	39	53	44	38	48	58
Contribution for egg Production[3] %		12	20	24	21	18	22	24
Egg Weight		39.56±2.18	40.62±2.26	46.54±1.94	48.24±1.65	47.69±1.04	50.13±1.45	49.34±1.67
Water in egg[4]		26	26	30	32	31	33	32
%Egg exported with Egg[5]	0	14	12	13	15	15	15	14
Conversion efficiency (%) metabolic water for egg production on to egg[6]		123	66	56	72	81	68	55