# The effect of water temperature and feed density on the performance of laying hens during heat stress

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## SUMMARY

An experiment was conducted in a climate chamber to study the effects of water temperature and feed density on the production characteristics of laying hens during heat stress. Following a preliminary period of adaptation, pullets at 25 weeks of age, were moved to the climate chamber and maintained at 38 °C from 8.00 Hrs to 17.00 Hrs and at 28 °C from 17.00 His to 8.00 Hrs at constant 55% relative humidity. A low density diet "A" (15% C.P.; 10.54 MJ/ kg ME) was compared to a high density diet "B" (25% C.P.; 12.15 MJ/ kg ME) at cool running water "C" of 7 °C and warm stagnant water "W" one °C lower than the ambient temperature in the chamber. The treatments were tested with 120 birds, arranged in 24 groups of 5 birds over 11 periods of 14 days.

Cool water and high density feed improve feed consumption, **egg weight, feed efficiency and final body weight ($p < 0.01$). Apart from egg weight, other egg quality characteristics were not affected by water temperature.**

## INTRODUCTION

**The documented effects of heat stress on the performance of laying hen include reductions in feed consumption, egg production, egg**

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weight, egg shell quality and an increase in mortality (Deaton, 1983). However, as a result of decreased feed consumption, often an improvement in feed efficiency occurs (De Andrade, Rooler and Featherstone, 1976). Despite the fall in maintenance requirement, the energy intake is then lowered to such an extent that body weight is also reduced and considerable mortality may take place (Smith and Oliver, 1971; Musharaf and Hassan, 1973; Sykes, 1976). the intake of all other essential nutrients is lowered and the hen is unable to maintain production. For this reason, it is necessary to increase the concentration of essential nutrients in the diet (De Andrade et. al., 1976).

When exposed to heat stress, the fowl starts to par', drinks more water and releases its metabolic heat through evaporatiot. . Under these conditions cool drinking may help dissipate the metabolic heat. Limited information is available on the effect of cool drinking water on the performance of laying hen at high temperature (Hill, 1976). Wilson and Edwards (1952) reported a decrease in body temperature of 0.4 °C with cool drinking water of 0 °C. Feed consumption was increased in two of their tests. Leeson and Summers (1975) reported-a rise in feed consumption and egg production when provided cool water at environmental temperature of 35 °C, but this was accompanied by a considerable body weight loss. A report by Miller and Sunde (1975) explained the absence of mortality under heat stress on the basis of availability of cool drinking water to the birds. Experiments with cattle (Bianca, 1964; Lofgreen, Givens, Morrison, and Bond, 1975) showed also some favourable effects of cool water on these animals when kept under heat stress.

This study was undertaken to examine the effects of drinking water temperature and nutrient density on the performance of white leghorn kept under heat stress.

## MATERIALS AND METHODS

*Birds:*

One hundred and twenty S.C. White Leghorn laying hens were used in this experiment. They were selected at 25 weeks of age from a pool of 240 pullets on the basis of equal bodyweight, egg production and general condition.

*Rousing and climate:*

During a preliminary period of six weeks, prior to the experiment, temperature was gradually raised from 20 °C to 32 DC in order to adapt the birds to the experimental conditions. During the last three weeks of this preliminary period, the temperature was maintained constantly at 32 °C.

Following the selection, the experimental birds were housed in a climatic chamber (Weiss Co, Giessen, W. Germany), and randomized in 24 cages, 4 batteries of six gages each, arranged in three tiers. In the first experimental week, the temperature was gradually changed from 32 °C to the experimental condition of 38 °C between 8.00 Hrs to 17.00 Hrs and to 28 °C from 17.00 Hrs to 8.00 Hrs. The light period of 14 hours was from 4 a.m. to 6 p.m. The relative humidity was maintained constantly at 55%. The ambient temperature and relative humidity could be maintained with an accuracy of 0.75 °C and 1.5% respectively. The climatic conditions were arbitrary chosen to simulate summer in central Sudan.

*Water supply:*

Water was offered through nipples. Half of the cages received stagnant water as commonly used in the practice. This was the warm water with a temperature of 1 °C lower than the ambient temperature in the climatic chamber. The remaining cages received a running water temperature of 7 8 °C. In the running Water system, the pressure of the water was slightly higher than normal, so the velocity of the running water had to be carefully controlled to enable the birds to drink. The two water systems were randomly assigned to the tiers of the four batteries. The temperatures of the two water systems was continuously recorded.

*Experimental feeds:*

The composition of the diets is given in table 1. Each diet was fed to 60 birds; 12 replicates, each with 5 birds per cage. Feed "A" presented the conventional laying ration used in the Sudan. Feed "B" was cornputed to have a higher nutrient density to cater for the expected low feed intake of about 60 g/ bird/ day recorded by Musharaf and Scheele (1978). Oyster shell was provided ad libitum in separate troughs to all birds to ensure sufficient calcium supply. Polyethylene was mixed in the diets as an indicator for determination of metabolizable energy (ME) of the diets (Janseen, Waanders and Terpstra, 1975).

*Table 1: The composition of the experimental feeds (%).*

| Ingredients% | Feed A | Feed B |
|---|---|---|
| Sorghum vulgare | 62.71 | - |
| Groundnut meal | 6.67 | - |
| Meat and bone meal | 5.28 | |
| Sesame meal | 4.88 | 18.23 |
| Maize | | 34.98 |
| Soybean meal (soiv. extracted) | - | 29.56 |
| Alfalfa meal | - | 2.46 |
| Soybean oil | 0.90 | 6.54 |
| Methionine (99%) | 0.18 | 0.11 |
| Lysine (77%) | 0.18 | - |
| Vitamin preparation | 0.49 | 0.74 |
| Limestone | 5.48 | 3.44 |
| Dicalcium phosphate | 0.70 | 0.49 |
| Polyethylene | 1.99 | 0.99 |
| Mineral preparation | 1.99 | 2.46 |
| Sulcafloc | 8.55 | |
| **Determined nutrient levels:** | | |
| Crude protein | 15.10 | 25.20 |
| Metabolizable energy (MJ / kg) | 10.54 | 12.15 |
| (KcaV kg) | 2518 | 2905 |
| **Calculated nutrient levels:** | | |
| Lysine | 0.63 | 1.08 |
| Methionine + cystine | 0.65 | 1.03 |
| Ca | 3.24 | 2.64 |
| P (total) | 0.71 | 0.76 |

All the feed was prepared at the same time before the start of the experiment and stored at - 20 °C. Whenever necessary, feed enough for one month was defrozen. The criteria of response were egg production, egg weight, feed consumption, feed efficiency, mortality and egg shell quality. The latter includes specific gravity, shell thickness, shell percentage and shell weight per cm square. Specific gravity was measured by floatation in saline solution (Hamilton, 1982). Measurements of shell thickness were done by a micrometer. Daily egg production was recorded. For egg weight, average weight was determined four days per period of 14 days (Tuesdays and Fridays). Bodyweight was determined at every period of 14 days. The experiment lasted 154 days i.e. 11 periods. All data were subjected to standard analysis of variance according to Snedecor and Cochran (1967).

## RESULTS AND DISCUSSION

The performance of the laying hens at the end of period 2, four weeks after the start of the experiment, is shown in table 2. Feed consumption (g/ hen/ day) of the two warm water groups was very low. Cool water, on the other hand, caused a substantial rise in feed consumption, approximately 23 - 35% or 10 - 15 g/ hen/ day ($p < 0.01$).

The long term effects of the treatments is presented in table 3. The sustained effects of water temperature and nutrient density is well illustrated on most parameters. Cool water and high density feed seem to improve feed consumption, egg weight, feed efficiency and final body weight ($p < 0.01$). Egg production (%) was not affected, but it remained well above 70% in all treatments, whilst it never dropped below 80% for cool water/ feed B (CB) throughout the study.

The effects of water temperature on egg quality characteristics is given in table 4. Apart from the effect on egg weight, there seems to be no influence on egg quality. Four birds died during the study, two from (CA) and another two from (WB) treatment.

The results confirm the favourable effects of cool water on the performance of the laying birds mentioned earlier by Wilson and Edwards (1952) and Leeson and Summers (1975). It shows the need to increase the nutrient density during summer in order to maximize egg production without losing body weight. The balance has to be maintained carefully between the extra feed ^^cts when the nutrient density is increased and the expected returns. Tit, .une applied if cool water is used in practice. Underground water is generally cooler than the ordinary tap-water and the possibility of using it with a running water system needs to be investigated.

*Table 2: Performance of the laying hens - four weeks after the start of the study - period 2.*

| Parameters | Treatments WA | CA | WB | CB | Feed effect | Water effect | Feed X water |
|---|---|---|---|---|---|---|---|
| Feed intake (g/h/d) | 58 | 69 | 58 | 74 | NS | ** | NS |
| Egg production (%) | 40 | 59 | 62.9 | 81.4 | ** | ** | NS |
| Egg weight (g) | 45.1 | 47.7 | 47.8 | 51.0 | ** | ** | NS |
| Feed efficiency (g egg/ g feed) | 0.43 | 0.48 | 0.58 | 0.59 | ** | NS | NS |
| Bodyweight at start (g) | 1456 | 1458 | 1446 | 1453 | - | - | - |
| Bodyweight at end of period 2 (g) | 1283 | 1300 | 1354 | 1448 | ** | ** | ** |

WA = Warm water feed A.
CA = Cool water feed A.
WB = Warm water feed B.
CB = Cool water feed B,
** = ($p < 0.01$).
NS - Non-significant.

***Table 3: Performance of the laying hens during the last two weeks of the study - period 11.***

| Parameters | WA | CA | WB | CB | Feed effect | Water effect | Feed X water |
|---|---|---|---|---|---|---|---|
| | Treatments | | | | | | |
| Feed intake (g/h/ d) | 89 | 94 | 75 | 87 | ** | ** | NS |
| Egg production (%) | 71.0 | 71.7 | 73.9 | 81.3 | NS | NS | NS |
| Egg weight (g) | 51.1 | 53.0 | 52.1 | 56.7 | | ** | N S |
| Feed efficiency (g egg/ g feed) | 0.39 | 0.42 | 0.50 | 0.54 | ** | ** | NS |
| Bodyweight at end of period 11(g) | 1374 | 1417 | 1535 | 1644 | NS | NS | NS |

**WA = Warm water feed A.**
**CA = Cool water feed A.**
**WB = Warm water feed B.**
**CB = Cool water feed B. ***
**= ($p < 0.05$).**
**** = ($p < 0.01$).**
**NS - Non-significant.**

***Table 4: The effect of water temperature on egg quality characteristics 16 weeks after the start of the study - period 8.***

| | Egg quality characteristics | | | | |
|---|---|---|---|---|---|
| Water temperature | Egg weight "g" | Specific gravity | Shell thickness e l pin t i | Shell percentage tt % HI | Shell weight ftg i cm2ti |
| Cool | 54.7,,[a] | 1.080 | 359 | 9.4 | 0.76 |
| Warm | 51.4 u | 1.084 | 358 | 9.4 | 0.76 |

**a, b = within the same column, means without a common superscript differ significantly ($p < 0.01$).**


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