Limiting the impact of heat stress on layers with management and nutrition

Exposure to seasonally high environmental temperatures is a major concern more and more frequent for the poultry industry. The optimal temperature of the environment for laying hens is between 18-24°C.

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According to Koppen Climate classification, most places on Earth are exposed to temperatures of 26°C and above several months a year. Heat stress is also intensified by high humidity. As for humans, the perception of high temperature increases with higher humidity.

Even if laying hens are less sensitive to high temperatures than broiler lines, temperatures higher than 24°C could affect hen performance.

Temperatures above the optimal temperature would impact the daily feed intake and consequently decrease egg numbers, shell quality, egg weight, etc.

Heat stress could have a tremendous impact on birds' growth and performance leading to an economic impact on farms.

Several measures such as management and nutrition can be taken to reduce the effect of heat stress in layers.

Effect of heat stress on layers

The first negative impact of high temperature is mainly affecting the feed intake of the laying hens, which means a reduction of feed intake with the increase of temperature.

A study was conducted in 2004 which compared several treatments with different temperatures and different relative humidity.

The three treatments applied were control (average temperature and relative humidity), cyclic (daily cyclic temperature and humidity), and heat stress (constant heat and humidity) for a duration of five weeks.

The result of the study, illustrated in Table 1 clearly shows the adverse effects of high temperatures on the daily feed intake of the hens, egg production, egg weight and egg quality.

Layers do not have sweat glands, which is why they are unable to lose their heat via transpiration. Heat is lost through direct exchange with the immediate exterior environment (air, litter, radiation) and comb, legs, feathers, and wings.

Heat loss is reduced when the temperature increases.

Therefore, this experiment shows how important it is to control the temperature when it is possible or to maximise the heat loss through air ventilation to avoid or minimise the impact on performances.

The heat between the bird and the environment is transferred by different means such as: radiation, convection, conduction, vasodilation and evaporation.

- **Radiation:**
Heat loss is proportional to the temperature difference between the body surface and the surrounding air: poorly insulated, hot roofs will increase temperature and heat stress.

- **Convection:**
The hen's hot body will release hot air into the surrounding environment. Airspeed will be useful to increase convection.

- **Conduction:**
Heat may flow from surface to surface, such as when the birds stand or sit on cool litter. Relatively unimportant.

- **Vasodilation:**
A method of heat loss where the blood vessels that are close to the outside of the body, such as in the comb and wattles of the bird, become wider and allow more blood to flow. This increase in blood flow near the outside of the body brings the internal body heat to the surface to be lost.

- **Evaporation:**
Birds use this method in higher temperatures in order to stabilise body temperature by increasing their respiration through panting (hyperventilation).

The severity effect of heat stress depends on many factors such as maximum temperature in the farms, relative humidity, duration of high

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Table 1. Effect of heat stress on laying hens.

Parameters	Control 23.9°C	Cyclic 23.9-35°C	Heat stress 35°C and 50% RH
Daily feed consumption (g/bird per day)	86.7^{a}	65.9^{b}	41.6^{c}
Hen day egg production (%)	87.4^{b}	82.5^{a}	56.2^{b}
Egg weight (g)	56.4^{a}	53.5^{b}	46.9^{c}
Shell weight (g)	5.06^{a}	4.76^{b}	3.50^{c}
Shell thickness (0.01mm)	34.8^{a}	33.9^{a}	28.3^{b}
Specific gravity (f/cm^{3})	1.074^{a}	1.072^{a}	1.064^{b}

a-c Means for the same parameter with different letters are significantly different (P<0.05)

Table 2. Effect of air velocity on laying hen performance between 9-48 weeks.

Air velocity (m/s)	Feed intake (g/hen/day)	FCR (g)	Egg weight (g)	HDEP (%)
<0.25	86.7^{b}	1.871	55.4^{c}	84.51^{b}
0.76	96.8^{a}	1.825	58.7^{b}	90.80^{a}
1.52	97.3^{a}	1.855	59.7^{a}	91.21^{a}
p-value	<0.0001	0.6020	<0.0001	<0.0001

a-c Means for the same parameter with different letters are significantly different (P<0.05)

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temperature exposure, house construction, ventilation system and air movement velocity. Closed, properly insulated farms are, therefore, much better than open farms in terms of performance. Increasing the air velocity in the farm helps the laying hens to dispense the temperature faster.

In the study shown in Table 2, a high air velocity compared to still air in the farm improves HDEP %, egg weight and feed intake of laying hens at a temperature of 27.8°C and relatively humid conditions around 84.51 % humidity.

Another method of reducing air temperature is pad cooling or fogging systems. Ventilated houses should have positive or negative pressure systems. High stock density in systems like the cage system or the aviary system can also deteriorate the temperature dispensed by the animals.

Avoiding high density is one solution to alleviate the heat stress effect.

Nutritional strategies

First of all, arranging the feeding time is significant for birds dealing with heat stress. Ad libitum feeding is not suggested.

Feeding should be done during the hours of the day when the temperature is not high. 30-40% of daily feed should be given early in the morning because, during late afternoon, a significant rise in body temperature can be observed.

This is not the hottest time of the day, but it is the peak time of digestion if the birds have been fed in the early morning.

This high body temperature may cause death in particularly severe cases. Therefore, 60-70% of daily feed should be given during the late afternoon.

Moreover, it is possible to add midnight lighting during the cold part of the night for one to two hours which is another possibility for the hens to have time for extra feeding and drinking. (If allowed by local regulations).

Good feed granulometry is important during heat stress too. The feed consumption will be reduced due to heat stress; therefore it is important to ensure an optimal feed intake with the correct feed presentation.

The ME requirement decreases as temperature increases to above 27°C, resulting a reduction of energy requirements for the hens. Above 27°C, it will start to increase again since the birds need additional energy for panting to reduce their body heat.

In this case, we need to provide the right amount of energy, according to the temperature. A laying hen regulates its Feed Intake (F.I.) according to the energy level within the feed. Nevertheless, this regulation is less efficient with high temperatures.

Another suggestion to reduce heat production is to change the composition of feed. Including oil in the diet has long proved to be beneficiary in hot climates. Because the digestion of fat produces less heat increase than the digestion of carbohydrates or proteins.

Protein levels should be arranged in diets to maintain productivity as feed consumption decreases during heat stress.

Also, lower feed intakes during heat stress require an increase in dietary amino acid levels (proportional to the percentage decline in feed intake) in order to maintain performance.

To conclude, adjusting protein and amino acids should be adapted to the real feed intake/bird/day. This is better than excessive protein levels in the feed.

Laying hens increase their water intake, during periods of heat stress. Water/feed intake ratios increase from approximately 2:1 at thermoneutral temperatures to 5:1 at heat stress temperatures. It is extremely important to provide clean, fresh drinking water at the correct temperature during the entire day.

Hens usually prefer to drink clean and fresh water. Especially cool drinking water can help the hens combat heat stress. This should be taken into account carefully even though it may be difficult to control under practical conditions.

It was reported that laying hens at 30°C consumed more feed and produced eggs with better eggshell quality when the temperature of their drinking water was reduced to 15°C in one case and 5°C in another.

Table 3. Serum concentration of vitamin C, vitamin E and corticosterone in broiler breeder hens exposed to high environmental heat stress at 32°C.

Components	Basal diet	BD + Vit C	BD + Vit E	BD + Vit C + Vit E
Vitamin C (g/ml)	7.87[a]	12.73[b]	7.26[a]	12.24[b]
Vitamin E (g/ml)	2.80[b]	1.63[a]	8.20[c]	8.35[c]
Corticosterone (ng/ml)	5.97[a]	3.23[b]	2.54[b]	2.78[b]

a-c Means in a row with no common superscripts are significantly different ($p < 0.05$).

Parameters	Thermoneutral 24°C	Heat Stress 35°C
Na	6.4[b]	11.0[a]
K	26.0[b]	54.2[a]
Cl	18.9[a]	11.3[b]
Ca	1.8[b]	4.0[a]
P	37.9[b]	60.4[a]

a,b Values within a column with no common superscripts differ ($P < 0.05$).

Table 4. Excretion in urine during 12 hours (mg/kg bw).

Reduction of corticosterone

Chickens are exposed to many stress factors during their life. Factors that may induce stress responses include stocking density, temperature, transport, feed restriction, feed contamination, fear and diseases.

One of the glucocorticoids is corticosterone which is the primary stress hormone in poultry and stimulates gluconeogenesis to provide the body with more energy when birds encounter stressful situations.

For laying hens, high corticosterone causes increased feed intake, reduced weight gain, elevated corticosterone concentrations and heterophil/lymphocyte ratios, higher feather picking, longer tonic immobility, and reduced immune functions.

In addition, it increases the weight of the liver and the abdominal fat pad.

Furthermore, corticosterone administration delayed the onset of egg laying, shorted the duration of peak production and thereby reduced hens' daily egg production.

That is why reduction of corticosterone levels should be targeted to achieve optimal productivity.

Adding vitamin C or vitamin E to the hen's nutrition can help to reduce this.

In the study shown in Table 3, corticosterone levels in the blood are reduced with a significance (at $p < 0.05$) by feeding diets supplemented with higher levels of vitamin C and/or vitamin E.

The addition of vitamin C (200mg/kg) and/or E (250mg/kg) to the diet could prevent decreases in eggshell quality and tibia bone strength by alleviating stressful effects from high environmental temperature in laying hens.

Prevention of respiratory alkalosis

During panting (hyperventilation) birds lose heat but there is excessive loss of CO_2 gas from their lungs and blood. Lower CO_2 in the blood causes blood Ph to elevate or become more alkaline which is called respiratory alkalosis.

The higher blood pH reduces the activity of the enzyme carbonic anhydrase, resulting in reduced calcium and carbonate ions transferred from the blood to the shell gland.

Another contributing factor to thin eggshells is a reduced intake of calcium and an increased loss of phosphorous. In the study shown in Table 4, birds were used to check urinary excretion data during heat stress maintained at 35°C for 36 hours.

The heat stress increased ($P < 0.05$) urine output from 52.3 to 109.9ml/12 hours and also increased total urinary Na, K, Cl, Ca and P.

The addition of potassium chloride, sodium bicarbonate and additional phosphorus can replace electrolytes lost during heat stress.

These treatments in the literature have been shown to be beneficial in reducing mortality in acutely heat-stressed flocks.

Conclusion

Seasonally, heat stress is one of the important factors that have an economic impact on laying hens in most parts of the world.

Anticipation is a key for minimising the effects of heat stress, it is therefore necessary to implement appropriate management and nutritional measures before the temperature rises.

All the management measures in the farms will help to increase hens' productivity rather than just altering diet compositions.

Finally, the continued genetic progress made by Novogen has allowed significant gains in both egg production and egg quality. It has also made it possible to have robust and resilient birds in all conditions of production.

Nonetheless, in order to fulfil the layers' genetic potential, the management and nutrition of the flock must be closely monitored and adapted to the local environment. ■

References are available from the author on request