Relations Among Environmental Temperature, Feed and Egg Production Performance of Laying Hens

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It is common in a modern large-scale egg-raising enterprise that chickens are bred only by a stipulated feed at a certain place. Consequently, it is impossible to change the place unrestrictedly or to select and take the feed suitable to the environment even if the environmental condition is not appropriate for chickens.

More important conditions than nutrition and feed when chickens are bred are to increase the utilizing efficiency of nutrition contained in the feed and to enhance the productivity by eliminating waste.

It is the Japanese feeding standard for chickens[1] which has been settled with such object, considering the fact that they may take in the nutrient necessary for the normal growth of chick or for the amount of egg production.

But in order to make chicks grow normally or to keep the percentage of egg production high for a long period, it is necessary to pay attention to environmental factors surrounding them and to make the environment not to become a stress to them.

These factors, however, have become a very difficult problem for a chicken raiser, since there are various factors which are related to each other. This report is intended to examine the influence which the environmental temperature extends the egg production performance and to investigate whether nutrient content in feed is necessary to be changed according to the temperature or not.

Relations between chickens and environmental temperature

It is necessary to keep the bodily temperature constant, balancing the amount of heat production in the body and the amount of heat radiation according to the change in environmental temperature.

In this case, such temperature condition in the constant temperature could be maintained, even if the chickens are not regulated by force by body temperature, which is called thermal neutrality and which is to be about 14°C-25°C in case of laying hens.

When the temperature exceeds to the range of proper heat, hens show a characteristic movement. Consequently, the observation of these movements could be a tentative criterion to judge whether the environmental temperature is proper or not. When the temperature rises, hens show the following movements:

1) They spread their main wings to increase the amount of heat radiation.

2) They drink more water than usually to augment the evapotranspiration from the surface of the respiratory organs and to increase the amount of heat radiation by evaporation heat.

3) The feed intake is decreased.

When the temperature goes down, they show the following movements:

1) They ruffle their feathers to increase the adiabatic effect to prevent the radia-

tion of body temperature.

2) They bury their unfeathered parts such as head or legs to prevent heat radiation.

3) The feed intake is increased.

Environmental temperature and nutrient level

It is well known empirically that the feed intake is decreased when laying hens are bred on high temperature condition. The nutrient which hens require could be considered dividing into one to be used to maintain their body and one to be used to produce eggs, etc.

The nutrient required for energy is influenced by the environmental temperature whose result is expressed by the increase and decrease in the feed intake. But the amount of protein and mineral, etc. contained in an egg produced is not related to the temperature, and it may be considered constant when the weight of egg is the same.

On the other hand, in the case of feeding standard for chickens each nutrient contained in feed is expressed by percentage, mg per 100 g or international unit.

Consequently it could be considered rational to give the feed whose nutrient content is increased, since the nutrient intake is decreased when the feed intake is reduced by the environmental temperature, and to give the feed whose nutrient content dwindles conversely when the feed intake is increased.

Especially in Japan there is considerable difference in atmospheric temperature through all the seasons between southern and northern districts since Japan's geographical condition is so long that it lies from south to north.

Then, the egg production experiment was conducted by changing the nutrient content in the feed provided using air-conditioned rooms (three rooms) where the temperature condition could be regulated, and the influence of the environmental temperatuer and the nutrient level of the feed exercising over the egg production performance have been examined.

Conditions of experiment of egg production: The level of temperature conditions has been taken to be 7 such as 7°C, 10°C, 15°C, 20°C, 25°C, 30°C, and 35°C, the crude protein content of the feed has been taken as 16 per cent and 19 per cent, and the energy (TDN) content has been taken as 62 per cent and 73 per cent. The experimental results at each temperature condition on these four kinds of feed combined (CP 16%-TDN 62%, CP 16%-TDN 73%, CP 19%-TDN 62%, CP19%-TDN 73%) are shown in Table 1 and Fig. 1. The relations in Fig. 1 expressed by mathematics are shown in Table 2.

As indicated in Table 1, it is proved that every measured item except the percentage of egg production is influenced by the temperature condition, but is not affected by crude protein content, and the one except the thickness of egg shell is influenced by TDN content. Subsequently, the relations among temperature, TDN content

Table 1. Relations between egg production performance and environmental temperature, crude protein, energy (TDN) contents of feed for laying hens

Temp. (℃)	Egg production (%)	Feed intake (g)	Feed conversion	Shell thickness (mm)
7	72	106	2.40	0.343
11	69	105	2.48	0.323
15	72	109	2.47	0.340
21	69	101	2.44	0.337
25	73	98	2.22	0.321
29	73	87	2.04	0.315
34	67	71	1.90	0.306
Crude prot.				
16%	71	97	2.25	0.327
19%	70	97	2.31	0.325
TDN				
62%	68	103	2.46	0.329
73%	72	91	2.10	0.323

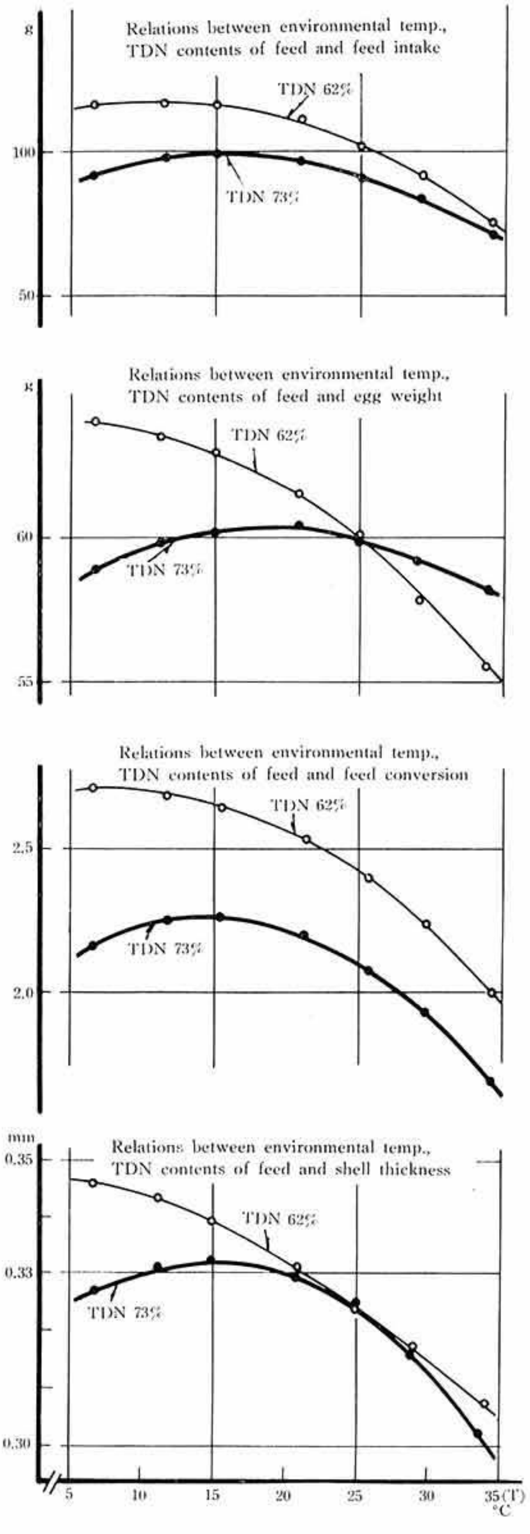

Table 2. Relations between egg production performance and energy (TDN) contents of feed for laying hens

	TDN contents of feed (%)	Equation	Temp. of maximum good result (℃)
Feed intake (g)	62	$116-0.076\,(T-10.2)^2$	10.2
	73	$100-0.089\,(T-15.6)^2$	15.6
Egg weight (g)	62	$64-0.01\,(T-5.5)^2$	5.5
	73	$60-0.01\,(T-19.0)^2$	19.0
Shell thickness (mm)	62	$0.359-0.0004\,(T-7.5)^2$	7.5
	73	$0.335-0.00007\,(T-14.7)^2$	14.7
Feed conversion	62	$2.55-0.001\,(T-8.0)^2$	8.0
	73	$2.28-0.001\,(T-7.6)^2$	7.6

T = Environment temperature

and egg production erformance are mainly described.

Feed intake: It is clear from Table 1 and Fig. 1 that the feed intake is influenced by the temperature, but Payne, et al.[2] have mentioned that the feed intake of laying hens is decreased by 1.6 per cent each time the temperature is increased by 1°C.

The results of this study show that the relation is expressed by the equations shown in Table 2 where the feed intake could be applied to a quadratic equation in the relation with the temperature, and the feed intake reaches the maximum value when the temperature is 16°C in the case of high energy ration and when the temperature is 10°C in the case of low energy ration.

If it is considered to be the proper temperature when the feed intake reaches the maximum, it is clear that the feed intake decreases rapidly with an increase in the temperature, exceeding this proper temperature. Such relations are shown in Table 3. Therefore, when the environmental temperature exceeds 30°C, the feed intake de-

Fig. 1. Relations between egg production performance and environmental temperature, TDN contents of feed for laying hens

Table 3. Relations between feed intake and environmental temperature, TDN contents of feed for laying hens

Temp. (℃)	Feed	
	TDN 62%	TDN 73%
0	109g	88g
5	115	90
10	117	97
15	115	100
20	110	98
25	100	92
30	87	81
35	70	66

creases by about 30-40 per cent, regardless of TDN content.

Percentage of egg production: It is an interesting problem to clarify whether the percentage of egg production is influenced by the environmental temperature or not, since the feed intake is greatly decreased when the temperature exceeds 30°C. Regarding this point Huston[3] has claimed that the White Leghorn is not apt to be influenced by high temperature rather than New Hampshire and white Plymouth Rock, and the significant difference has not been statistically proved also in our experiment, since the percentage of egg production is 67 to 73 percent regardless of the high temperature condition of 35°C of maximum temperature.

Weight of egg: It is substantiated by various studies on the relation between temperature and weight of the egg that the weight of egg decreases in high temperature condition. The results of our study are shown in Fig. 1 where a peculiarity is that the temperature is 5.5°C when TDN content of feed is low, and it is 19°C when the content is high and where the weight of egg reaches the maximum value. This is a point of difference to the old knowledgement.

If the weight of egg is not greatly decreased with an increase in temperature in the case of high energy ration, it is necessary to reexamine the old way of thinking in Japan that the decrease in egg production performance is prevented by increasing the feed intake, giving hens low energy ration on high temperature condition in summer. Moreover, it is also necessary to investigate the level of vitamin and mineral properly on high energy ration.

Thickness of egg shell: The thickness of egg shell shows the similar tendency to the feed intake as mentioned before. The thickness of egg shell reaches the maximum value when the temperature is 8°C and TDN content of feed is 62 per cent and when the temperature is 15°C and the content is 73 per cent.

Feed conversion: Nishida, et al.[4] have pointed out that the feed conversion is important from the economical point of view. Generally it is considered that the feed conversion is improved with an increase in temperature, which has been ascertained also from the result of our study, as shown in Fig. 1.

References

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