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Effect of Environmental Conditions in Poultry Houses on the Performance of Laying Hens

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Abstract: This experiment was conducted to determine the effects of environmental factors (ammonia, carbon dioxide, hydrogen sulfide, dust, temperature, relative humidity) on egg production feed consumption and feed conversion ratio. Lohman layers (n = 288, 24 wks of age) were blocked according to the location of cages. In the analysis made, it was observed that air of poultry house and productive performance were significantly affected from seasonal changes. In winter and spring months, the amount of feed consumed per kg egg production was found higher in terms of summer and autumn months. In addition, there was a negative and significant correlation between carbon dioxide and relative humidity and egg production. Also, in case of the existence of the increase in gases of poultry houses, it was determined that feed conversion ratio becomes worse.

Key words: Environmental condition, laying hens, performance

Introduction

As in other husbandry fields, the aim in chicken production is to obtain the yield in a desirable level at the lowest cost. As the chickens have spent their life in poultry houses, in order for the chicken to be able to perform their yield capacities entirely, they should be kept in a good environment conditions with a good care as well as genetic features. An adequate environment within poultry houses is a very important requirement for success in the poultry industry. In poultry houses environmental conditions mean physical (heat, humidity and air movement) and chemical factors (ammonia and carbon dioxide in the compound of the air).

Chickens and their wastes in poultry houses generate different forms of air pollution, including ammonia, carbon dioxide, methane, hydrogen sulfide and nitrous oxide gases, as well as dust (Kocaman *et al.*, 2005). Gases such as carbon dioxide, ammonia and methane may accumulate and reach toxic levels if adequate ventilation is not maintained. These different air pollutants may cause risk to the health of both chickens and farm workers. Poor environments normally don't cause disease directly but they do reduce the chickens' defenses, making them more susceptible to existing viruses and pathogens (Quarles and Kling, 1974).

Aerial ammonia in poultry facilities is usually found to be the most abundant air contaminant. Ammonia concentration varies depending upon several factors including temperature, humidity, animal density and ventilation rate of the facility. Chickens exposed to ammonia showed reductions in feed consumption, feed efficiency, live weight gain, carcass condemnation, and egg production (Charles and Payne, 1966; Quarles and Kling, 1974; Reece and Lott, 1980). Humidity and temperature also have an impact on air quality.

Table 1: Ingredients of the experimental diets

Ingredient	
Corn	46.00
Soybean meal (44% CP)	21.00
Wheat	7.00
Barley	3.00
Wheat bran	8.75
Molasses	2.00
Limestone	9.00
Dicalcium phosphate[1]	2.00
Salt	0.40
Vitamin-mineral premix[2]	0.40
Methionine[3]	0.15
Lysine[4]	0.15
Ethoxyquin[5]	0.15

[1]Each kilogram contained: Ca, 24% and P, 17.5%.
[2]Each kilogram contained: Vitamin A, 15,000 IU; cholecalciferol, 1,500 ICU; DL-α-tocopheryl acetate, 30 IU; menadione, 5.0 mg; thiamine, 3.0 mg; riboflavin, 6.0 mg; niacin, 20.0 mg; panthotenic acid, 8.0 mg; pyridoxine, 5.0 mg; folic acid, 1.0 mg; vitamin B_{12}, 15 µg; Mn, 80.0 mg; Zn, 60.0 mg; Fe, 30.0 mg; Cu, 5.0 mg; I, 2.0 mg; and Se, 0.15 mg.
[3]DL-methionine. [4]L-lysine hydrochloride. [5]An antioxidant.

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Table 2: Means (±S.D.) of performance traits of laying hens and environmental parameter in poultry house

	Winter Mean±S.D.	Spring Mean±S.D.	Summer Mean±S.D.	Autumn Mean±S.D.	P
EP	81.51±5.72[c]	92.84±2.83[a]	90.37±1.79[a]	87.28±3.58[b]	***
FC	129.02±4.89[b]	137.57±5.29[a]	127.28±6.41[a]	118.26±5.29[c]	***
FCR	2.11±0.18[a]	2.18±0.16[a]	1.95±0.09[b]	1.79±0.06[c]	***
CO_2	2700.0±904.9[a]	1623.1±1140.3[b]	715.4±247.8[c]	950.0±308.9[c]	***
NH_3	25.06±13.40[a]	16.46±7.89[b]	9.31±2.56[c]	10.50±2.32[bc]	***
H_2S	5.94±3.99[a]	7.00±3.03[a]	3.54±1.56[b]	1.75±0.62[b]	***
Temp	17.67±2.09[c]	18.38±2.18[bc]	22.38±2.87[a]	19.92±2.64[b]	***
RH	72.22±6.65[a]	67.00±6.75[a]	60.46±8.29[b]	66.58±8.77[a]	**
Dust	2.19±0.49	2.24±0.43	2.34±0.37	2.02±0.39	NS

EP = egg production (%); FC = feed consumption (g/d); FCR = feed conversion ratio (kg feed consumed per kg egg produced);
CO_2 = carbon dioxide (ppm); NH_3 = ammonia (ppm); H_2S = Hydrogen sulfide (ppm);
Temp = Temperature (°C); RH = relative humidity (%); Dust = dust (mg/m^3)

Table 3: Correlation coefficients (r) between performance traits and environmental parameters of poultry house

	EP	FC	FCR	CO_2	NH_3	H_2S	Dust	Temp	RH
EP	1								
FC	0.1	1							
FCR	-0.02	0.66**	1						
CO2	-0.36**	0.16	0.65**	1					
NH3	-0.21	-0.01	0.59**	0.86**	1				
H2S	0.11	0.31*	0.72**	0.69**	0.74**	1			
Dust	0.28*	0.16	-0.01	-0.14	-0.16	-0.1	1		
Temp	0.16	-0.28*	-0.42**	-0.45**	-0.43**	-0.29*	0.17	1	
RH	-0.36**	0.11	0.18	0.35**	0.28*	0.07	0.09	-0.36**	1*

* $P< 0.05$ **$P<0.01$. EP = egg production (%); FC = feed consumption (g/d); FCR = feed conversion ratio (kg feed consumed per kg egg produced); CO_2 = carbon dioxide (ppm); NH_3 = ammonia (ppm); H_2S = Hydrogen sulfide (ppm); Temp = Temperature (°C); RH= relative humidity (%); Dust= dust (mg/m^3)

Ventilation is an important consideration for controlling heat, humidity and different gases. In the poultry houses of laying hen, optimal temperature is required up to 15-20°C. Environmental temperature was correlated with many measures of performance including feed and water consumption, body weight, egg production, feed conversion, and egg weight (Sterling *et al.*, 2003). The reduction of egg production under heat stress may have been related to the altered respiratory pattern (Xin *et al.*, 1987). In case of reduction of environmental temperature, they consume much feed in order to maintain their body heat (Turkoglu *et al.*, 1997).

Studies on the effects of dust in animal housing generally indicate potential for adverse effects on the healthy, growth and development of animals (Janni *et al.*, 1985; Feddes *et al.*, 1992). Respirable aerosol particles within poultry housing have been shown to decrease bird growth (Butler and Egan, 1974), increase disease transfer within flocks, and increase condemnation of meat at processing plants (Simensen and Olson, 1980).

In poultry houses of laying hen, optimal relative humidity should be between 60-70%. In case of low relative humidity, dust has increased, and in addition to this, the respiratory diseases in the chickens have been seen (Ozen 1986; Turkoglu *et al.*, 1997).

This research was conducted to determine the effects of environmental factors (ammonia, carbon dioxide, hydrogen sulfide, dust, temperature, relative humidity) on egg production, feed consumption and feed conversion ratio.

Materials and Methods

In present study, 288 Lohman layers with uniformity of 94% were blocked according to the location of cages (48x45x45 cm, widthxdepthxheight). Each treatment was replicated in 6 cages. The hens were 26 wks of age at the beginning of the experiment and the study was conducted over a period of 60 wks. Standard feeder, watered, lighting and densities were used throughout the experiment. The diets offered ad libitum in the experiment are described in Table 1.

Productive performance was evaluated by measuring egg production, feed intake, and feed conversion ratio. Feeding, egg collection, and recording were done once daily, in the morning. Egg production was recorded daily. Feed was weighed at feeding time, usually every day, and than left in the feeder at the end of the week was weighed and subtracted from that which was added during the week. This gave the total feed intake for 1 wk,

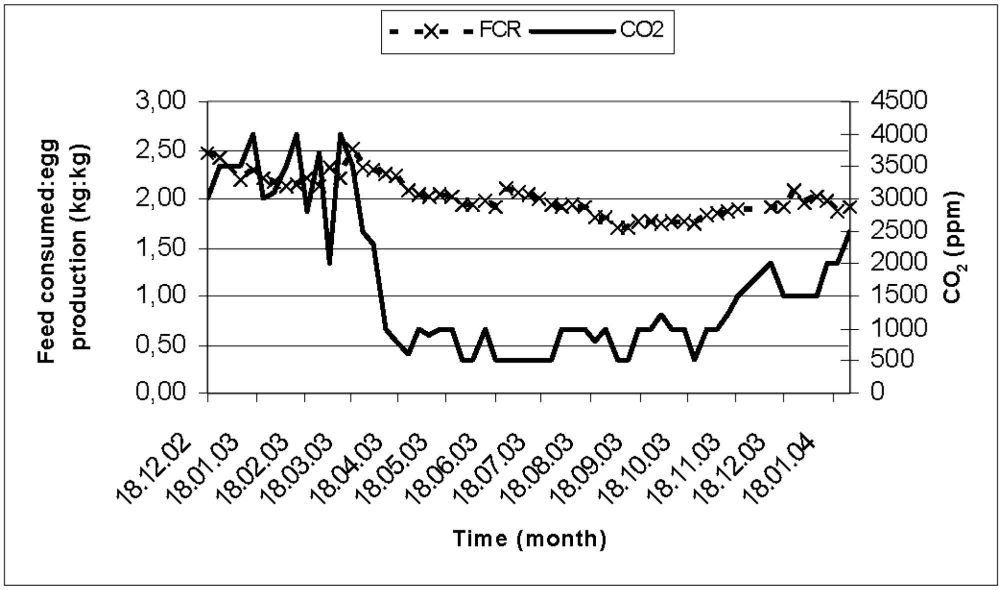

Fig. 1: The effect of CO_2 level on feed conversion ratio

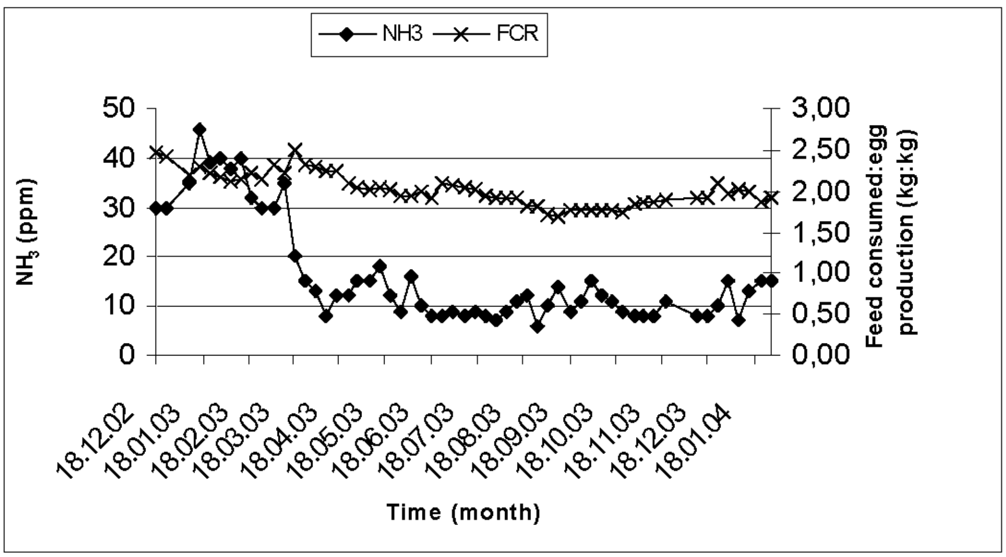

Fig. 2: The effect of NH_3 level on feed conversion ratio

and from this total the daily feed intake per hen was calculated. Feed conversion ratio (FCR) was expressed as kilogram of feed consumed per kilogram of egg produced.

Temperature (^{o}C) and relative humidity (%) were recorded continuously by using a thermohygrograph. Air flow velocity was measured by digital anemometers. Concentrations of carbon dioxide (CO_2, ppm), ammonia (NH_3, ppm) and hydrogen sulfide (H_2S, ppm) were determined by utilizing Multiple Gases Detection Instrument manufactured in Drager, Germany. Total dust concentration was measured as mg/m^3 by using a personal dust monitor model HD-1002 by SKCLtd., U.K. The levels of the gases and dust were determined once in a week during the study. The data were analyzed using in SPSS 10.0 computer package program (SPSS, 1994).

Results and Discussion

Air for poultry buildings have less than 3000 ppm CO_2, 15 ppm NH_3, 3 ppm H_2S and 2 mg/m^3 dust at bird level. Recommended temperature and relative humidity

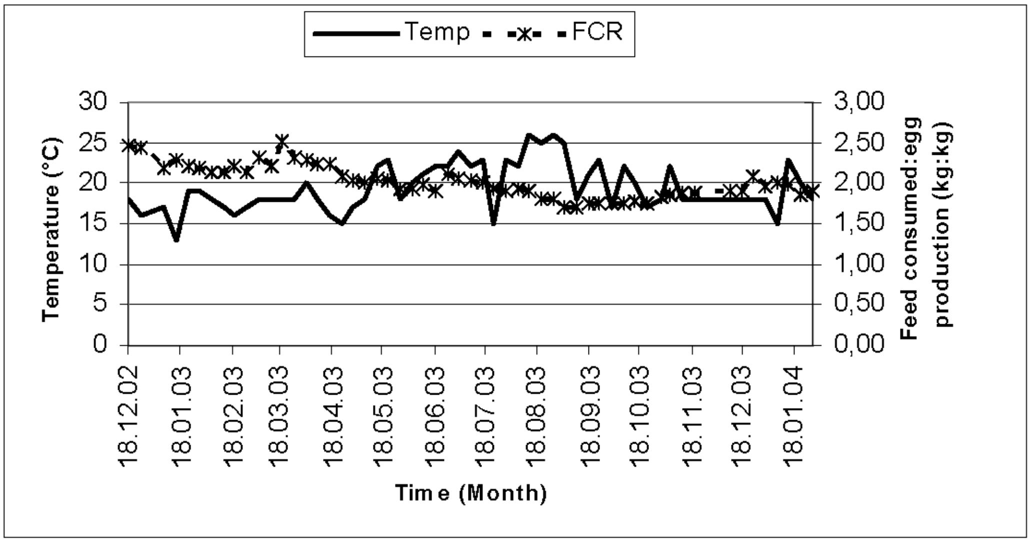

Fig. 3: The effect of temperature on feed conversion ratio.

values for caged layer houses should be 15-20°C and 60-70% (Turkoglu *et al*., 1997; Ellen *et al*., 2000; Chastain, 2005; Kocaman *et al*., 2005).

The values belonging to environment of poultry house and performance traits of laying hens were analyzed by taking different seasons into consideration, and presented in Table 2. The amount of relative humidity, temperature, hydrogen sulfide, ammonia and carbon dioxide in winter and spring months indicated statistically significant in terms of the months of summer and autumn.

It was observed that daily feed consumption and feed conversion ratio in summer and autumn months were lower than those of winter and spring months. Feed consumed per kg egg production, the hens consumed less was found to be in the months of spring and summer than that of winter's months. Correlation coefficiencies among various parameters examined in the present study were given in Table 3. It was determined that there was very significant and negative correlation between relative humidity, and egg production and carbon dioxide. As the values of carbon dioxide and relative humidity in the poultry houses increased, egg production decreased. Also, depending to the increase in the carbon dioxide, ammonia and hydrogen sulfide in poultry houses, it was observed that feed conversion ratio become worse. This relation can be better observed from the graphics of Fig. 1 and Fig. 2. A negative correlation between daily feed consumption and temperature in poultry houses was detected. As the temperature of poultry house increased, feed consumption reduced. In addition to, feed conversion ratio also decreased (Fig. 3). A negative correlation between temperature and feed consumption was reported by Xin *et al*. (1987) and Turkoglu *et al*. (1997)

In colder climates as Erzurum province of Turkey, many poultry houses can not maintain proper ventilation rates. Gases produced in the manure build up rapidly, often reaching harmful levels. Good air quality management practices require heating and ventilating systems that provide a balanced environment. Poor environments normally don't cause disease directly but they do reduce the chickens' defenses and performance, making them more susceptible to existing viruses and pathogens.

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