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The Investigation of Heating and Cooling Days with the Method of Degree-day in Broiler Poultry Housing

[1]A. Atilgan and [2]A. Akyuz
[1]Department of Agricultural Structures and Irrigation, Faculty of Agriculture, Suleyman Demirel University, Isparta, Turkey
[2]Department of Agricultural Structures and Irrigation, Faculty of Agriculture, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Turkey

Abstract: The degree-day values are used for fundamental design parameters in many applications, mainly related to heating and cooling, such as power generation and consumption, agriculture, animal barns, architecture, snow melt estimation, environmental energy planning and military domains. In this study, inside temperatures measured in a poultry house depending on outside temperature was calculated employing degree-day method. The number of heating and cooling days was determined for each production period. Experimental period lasted total 241 days corresponding 6 growth period. This period consist of 86 heating 11 suggested and 144 cooling days. A poultry house can be operated economically by optimizing energy consumption calculating degree-days value.

Key words: Broiler, degree-day, poultry housing, temperature

INTRODUCTION

The characteristics of animal-environment systems (temperature, moisture, various gases, diseases, etc) along with the balanced and sufficient feeding are vital to increase animal production. Optimum environmental conditions should be provided to the animals to achieve higher productivity (Yildiz, 2005). Acceptable conditions are most commonly established based on temperature (Anonymous, 1993). Likewise, Moura and Naas (1996) reported that the increase in metabolic diseases such as ascitis and sudden death in birds are more directly related to temperature than to the lack of ventilation. When comparing the bird performance at temperature ranges of 21 to 22°C and 17 to 35°C, it was found that the productivity indexes were better for the case with more constant temperature, being displayed as less sanitary problems. Thomason *et al.* (1987) stated that chickens have to be kept at certain controlled temperatures for the first two weeks, since they don't have the ability to adapt to large temperature variations at those ages. Then, they concluded that it is necessary to design poultry houses with proper equipment to keep temperatures not lower than 27-30°C and higher than 32-35°C.

Climate conditions constitute some of the most important factors determining the cooling and heating systems in animal barns. Heating and cooling periods during a year require fuel amounts depending on temperature of the area concerned (White, 1979). However, temperatures cannot be used simply by reading the outputs of measurement devices set in poultry houses or meteorology stations. Special methods are required to make that information useful. A common and easy to use approach is the method of degree-day method (Gultekin and Kadioglu, 1996).

Corresponding Author: A. Atilgan, Department of Agricultural Structures and Irrigation, Faculty of Agriculture, Suleyman Demirel University, Isparta, Turkey
Tel: +90 246 211 3875 Fax: +90 246 237 1693

The degree-day method is one of the well-known and the simple methods used in the heating, ventilating and air-conditioning industry to estimate heating and cooling energy requirements (Buyukalaca *et al*., 2001). Degree-days are defined as deviations of actual temperature values form standardly adopted base levels, which have significant meanings in lives of human, animal and plants (Sen and Kadioglu, 1998). Degree-days are used as a means of comparing heating (or cooling) requirements from one year to another or from one part of the country to another. They take into account the influence that outside air temperature has on the heating load (Anonymous, 2005).

The objective of this study was to determine the heating and cooling degree-days of a curtain-sided poultry house utilizing the degree-day method.

MATERIALS AND METHODS

The experiment was conducted in a curtain-sided poultry house of 4.40 m height, 61.7 m length and 12.30 m width with asbestos-tiled roof with air inlet. Reeled nylon curtain system was used to open and close for air circulation in summer against high radiation and for cold protection in winters in the north and south facing sides of the house. A total of 55.660 birds (Hubbard, Avian and Anac) were housed. This flock was fed during a six-week (37-46 day feeding period). Feeding dates, growing period and the number of birds housed during the experiment are given in Table 1. The experimental period corresponded to the growth phase (37-46 days) of birds. Rice hull was used as bedding material.

Radiant heaters were used to heat poultry house during winter period. Daily average Poultry House Inside Temperatures (PHIT), °C, were measured using computer aided measurement set comprising of a computer, a data logger (12 AD/DA) and diode type temperature sensors consisting (KTY-81) in growing periods between December 1997 and November 1998. All the temperature sensors were placed in 26 locations distributed in the house and located 50 cm above the floor to measure the temperatures in the vicinity of chickens properly.

Method of Degree-Day

Generally, a degree-day fixes the value that expresses the added temperature of the environment. It gives the value of quantity and duration when the air temperature becomes lower or higher than a determined threshold value, which is known as its base temperature (Hitchen, 1981; Matzarakis and Balafoutis, 2004). Degree-day values are defined when inside barn temperatures drop below certain temperatures and these values are called as the Suggested Poultry House Inside Temperatures (SPHIT), °C and are given in Table 2 based on growing period of birds. In other words, SPHIT are simply the desired temperatures and they vary depending on the purpose, animals, region, latitude and topographic conditions.

The daily degree-day value of a poultry house is the difference between the PHIT and SPHIT. In the same manner, degree-day value over a period is the cumulative sum of the difference between PHIT and SPHIT for weeks. Therefore, poultry house should be heated when PHIT drops below SPHIT and cooled when PHIT increase above SPHIT.

Heating degree-days are defined as the mean number of degrees by which the outside temperature on a given day is less than some base temperature, totaled for all the days in a period. For example, if the outside temperature for the whole day is 1°C less than the base temperature, this would constitute 1 degree-day. Cumulative sum of daily Heating Degree-day (HDD) values are obtained with the following equation (Gultekin, 1995; Buyukalaca *et al*., 2001; Kadioglu *et al*., 2001):

$$\mathrm{HDD} = \sum_{i=1}^{n} (\mathrm{SPHIT} - \mathrm{PHIT}) \text{ for } (\mathrm{PHIT} < \mathrm{SPHIT}) \qquad (1)$$

Table 1: Feeding dates, growing period and the number of birds housed during the experiment

Birds	Feeding dates	Growing period No.	The number of birds
Anac	12/29/1997-02/09/1998	1	10000
Avian	02/19/1998-03/30/1998	2	10000
Hubbard	04/19/1998-05/25/1998	3	10000
Anac	06/12/1998-07/18/1998	4	7500
Avian	08/05/1998-09/10/1998	5	8160
Hubbard	09/29/1998-11/13/1998	6	10000

Table 2: Suggested poultry house inside temperatures for gradual reduction (Thomason *et al*., 1987; Erensayin, 1991; Lindley and Whitaker, 1996; Lacy, 2002)

Age (Weeks)	SPHIT (°C)
1	30-32
2	28-30
3	26-24
4	23-24
5	22-23
6	20-21

where;

HDD = the cumulative sum of daily heating degree-days for n number of days

n = the total number of days during the period.

Cooling degree-days are defined similarly, as the mean number of degrees by which the outside temperature on a given day exceeds a base temperature (Anonymous, 2005). Cumulative sum of daily Cooling Degree-day (CDD) values are obtained with the following equation (Gultekin, 1995; Buyukalaca *et al*., 2001; Kadioglu *et al*., 2001):

$$\text{CDD} = \sum_{i=1}^{n}(\text{PHIT} - \text{SPHIT}) \text{ for } (\text{PHIT} > \text{SPHIT}) \tag{2}$$

RESULTS AND DISCUSSION

The daily average Poultry House Inside Temperature (PHIT), Poultry House Outside Temperature (PHOT) and Suggested Poultry House Inside Temperatures (SPHIT) as a function of days for 6 growing periods to determine the cumulative sum of daily Heating Degree-Days and (HDD) and cumulative sum of daily Cooling Degree-Day (CDD) are presented in Fig. 1 a-f. It is evident from Fig. 1a that radiant heating system overworked during the first growing period except the fifth week since PHIT exceeded SPHIT at this period of time. This will affect health and growth of poultry inside and increase fuel consumption, hence cost of operation. On the other hand, during the second growing period (February19-March 30), even though winter conditions are prevalent, it was determined that radiant heating system did not work sufficiently during the second growing period except the sixth week since PHIT was lower than SPHIT at this period of time (Fig. 1b). SPHIT exceeded PHIT during the fifth growing period (August 5-September 10), indicating that poultry house was not sufficiently cooled even though reeled nylon curtain system was open for air circulation in summer conditions (Fig. 1e).

The daily average PHIT as a function of time (Fig. 1a-f) have been examined for heating and cooling degree-day method in order to identify the temperature variation during each growing period. Heating and cooling degree-days calculated based on Eq. 1 and 2 and the ideal temperature counted from each growing period are summarized in Table 3. The number of heating and cooling days determined for the first growing period (December 29-February 9) is 9 and 31, respectively. Poultry house inside temperature stayed at ideal temperature only for three days at the mentioned period of time. On the other hand, the number of heating and cooling days during the second

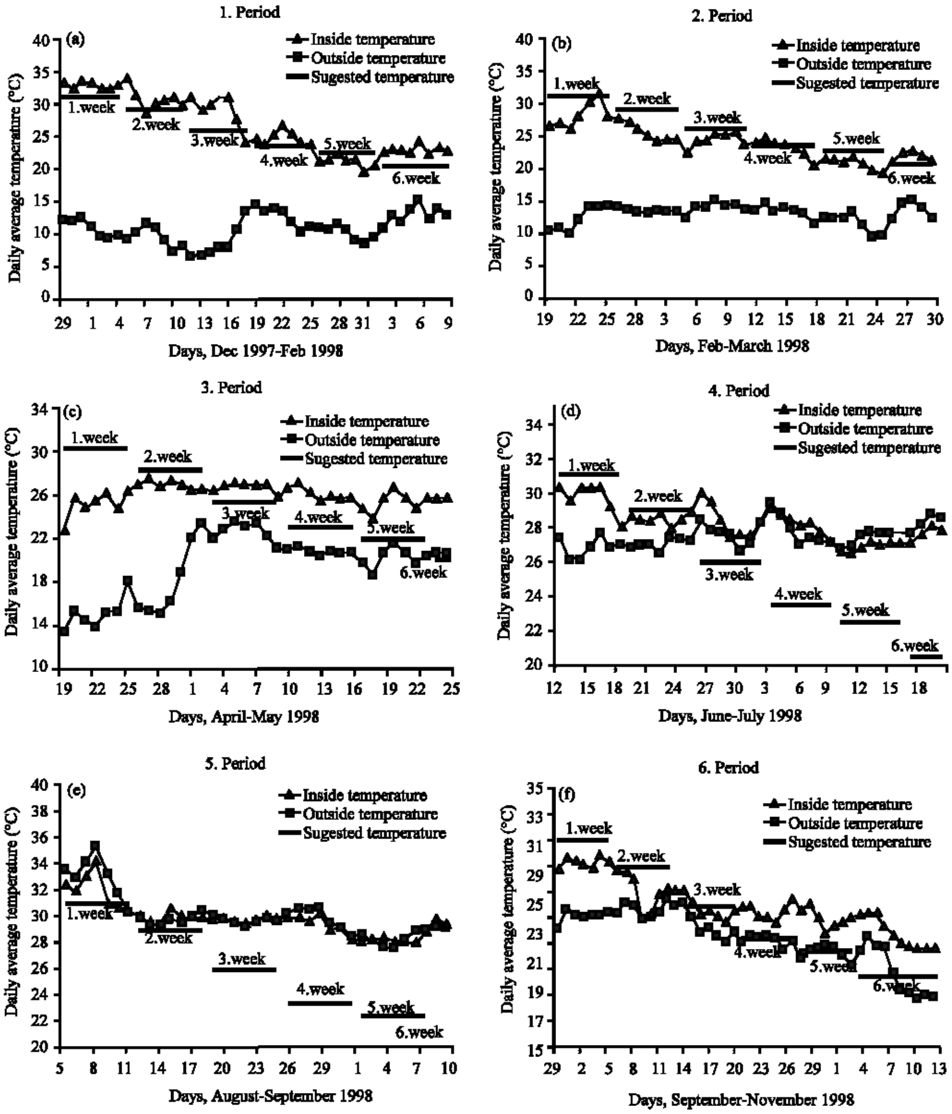

Fig. 1: Change in heating and cooling days during the growth periods

Table 3: Number of days for heating, cooling and ideal temperature during 6 growing periods

Number of growing periods	Number of heating days	Number of ideal temperature days	Number of cooling days	Number of measurement days
1 (Fig. 1a)	9	3	31	43
2 (Fig. 1b)	31	2	6	39
3 (Fig. 1c)	14	0	23	37
4 (Fig. 1d)	12	1	26	39
5 (Fig. 1e)	1	4	32	37
6 (Fig. 1f)	19	1	26	46

growing period (February19-March 30) was 31 and 6, respectively. The number of ideal temperature counted was 2. It is evident from Fig. 1a and b and Table 3, being the number of heating and cooling degree-day higher or lower than that of ideal temperature for the first and second growing periods indicates that optimum temperature conditions were not maintained for broiler chickens. The similar analysis can be applied to the other growing periods.

Method of degree-day can be used for calculation of energy requirements for heating and cooling of buildings future and energy planning in the developed countries. This method can be also applied to predict the energy requirement of agricultural structures such as poultry houses. Furthermore, capacity of ventilation, heating and cooling of poultry house can be calculated utilizing this method (Gultekin and Kadioglu, 1996). Therefore, it can be concluded that the method may be used to assess the potential for heating and cooling of a given barn for which the balance temperature point is measured or estimated. Hence, grower could save money cutting down the unnecessary energy expenses.

CONCLUSIONS

Temperature observations are necessary for many human and animal related activity assessments through the heating and cooling degree-days concept. The heating and cooling degree-days considering SPHIT values for broiler poultry house were determined using temperature measured from 26 locations distributed in the curtain-sided poultry house. Chicken growth took place during 6 periods amounting to 241 days. This time included 86 heating, 11 ideal and 144 cooling days. The numbers of the heating and cooling degree-days for six growing periods were calculated. Using the findings of this study, excessive cooling and/or heating could be prevented, which is important in minimizing excessive expenses that could result from lower or higher than necessary levels of temperature.

REFERENCES

Anonymous, 1993. Environmental Control for Animals and Plants. ASHRAE Handbook Fundamentals, Chapter 9, USA.

Anonymous, 2005. Energy consumption, 16293: Environmental Engineering Science I. (Web Document) http://www.esru.strath.ac.uk/Courseware/Class-16293/10-Energy_consumption.pdf

Buyukalaca, O., H. Bulut and T. Yılmaz, 2001. Analysis of variable-base heating and cooling degree-days for Turkey. Applied Energy, 69: 269-283.

Erensayin, C., 1991. Broiler chicken production. Scientific-technical-practical poultry production, Ankara, (In Turkish), pp: 460-464.

Gultekin, M.L., 1995. Distribution of degree-day in Turkey. Department of Meteorology Engineering, Masters Thesis, Istanbul Technical University, Istanbul (In Turkish).

Gultekin, M.L. and M. Kadioglu, 1996. Distribution of heating and cooling degree-days in Marmara region. J. Installation Engin. (In Turkish), 3: 33-41.

Hitchen, E.R., 1981. Degree days in Britain. Building Services Engineering Design and Technology, 2: 73-82.

Kadioglu, M., Z. Sen and L. Gultekin, 2001. Variations and trends in Turkish seasonal heating and cooling degree-days. Climatic Change, 49: 209-223.

Lindley, J.A. and J.H. Whitaker, 1996. Poultry Housing. Agricultural Buildings and Structures, USA, pp: 565-591.

Lacy, M.P., 2002. Broiler Management. In: Commercial Chicken Meat and Egg Production. Bell, D.B. and W.D. Weaver (Eds.), 5th Ed., pp: 829-868.

Matzarakis, A. and C. Balafoutis, 2004. Heating degree-days over Greece as index of energy consumption. Int. J. Climatol., 24: 1817-1828.

Moura, D.J. and I.A. Naas, 1996. Thermal efficiency of poultry housing. International Conference on Agricultural Engineering, Madrid.

Sen, Z. and M. Kadioglu, 1998. Theoretical risk for degree-day calculations. Theor. Applied Climatol., 61: 121-126.

Thomason, D.M., K.C. Lepley and M. Dendy, 1987. Poultry brooding. American Soybean Association, St. Louis.

White, L.M., 1979. Relationship between meteorological measurements and flowering of index species to flowering of 53 plant species. Agric. Meteorol., 20: 189-204.

Yildiz, Y., 2005. Environment control in animal barn. Cukurova University, Faculty of Agriculture, Deparment of Agricultural Machinery, Adana, (In Turkish).