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DETERMINATION OF HEATING AND COOLING DEGREE DAYS FOR BROILER BREEDING IN THE TIGRIS BASIN

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Abstract

Nowadays, despite complex and sophisticated methods for the energy analysis in buildings, the degree-day method, which is one of the most important energy forecasting techniques, is still important. During the research, heating and cooling degree-day values were calculated using dry-bulb thermometer temperature values of long years of five cities (Diyarbakır, Batman, Siirt, Sirnak and Mardin) located in the Tigris Basin. Six different base temperature values were used for each province located in the research area in order to calculate the heating and cooling degree-day values in broiler breeding. Within the proposed six base temperature values, the most heating degree-day values were in Sirnak, and the least were in Batman province. Cooling degree-day values were calculated in the same way. The most cooling need was in Mardin province, except the base temperature value proposed for the first week. The least cooling day values were in Sirnak province. Regression coefficients were obtained by correlating heating and cooling degree-day values and six proposed base temperature values. It was determined that the regression coefficients for all provinces between cumulative heating and cooling degree-day values (dependent variable) and average annual heating and cooling degree-day values and independent variable, in other words, proposed base temperature values, varied between 0.993-0.999, and there was a very strong relationship in a positive way. If the numbers of heating and cooling degree-days are low in a region, then it can be said that the region is suitable for agricultural production. In accordance with the data obtained in the study area, it was concluded that Batman was the most suitable province for broiler breeding in terms of both heating and cooling degree-days.

Key words*: broiler, cooling degree day, heating degree day, Tigris Basin.*

INTRODUCTION

Nowadays, despite complex and sophisticated methods for the energy analysis in buildings, the degree-day method, which is one of the most important energy forecasting techniques, is still important.

In the degree-day method, the energy need of a building is basically directly proportional to the difference between the equilibrium temperature which is related to the building's indoor temperature and the outside air temperature of the place where the building is located. If the indoor temperatures of the building and indoor heat gain are stable, the energy required for the heating and cooling needs of the building can be predicted with high precision using the values obtained from the degree-day method (Bulut et al., 2007).

When the efficiency of heating, ventilation and air conditioning systems and the building's usage are stable, the degree-day method is used as the simplest energy analysis method.

Although the energy consumption of a building can be calculated using computer program packages specially developed for this purpose, the degree-day method and balance point temperature, its basic concept, remain important (Buyukalaca et al., 1999).

Variation in space heating and cooling needs is measured in degree-days method. Degree-day calculations are performed by means of long-term analysis of representative meteorological data (Sarak and Satman, 2003).

The degree-day method is commonly used to estimate energy consumption for heating and cooling in residential, commercial, and industrial buildings, as well as in greenhouses,

livestock facilities, storage facilities and warehouses (Yildiz and Sosaoglu, 2007).
The main purpose of this study was to determine the most suitable province in the Tigris Basin for broiler breeding using heating and cooling degree-day values obtained with the dry-bulb thermometer temperature values of long period of the study area.
It was aimed at guiding the manufacturers planning to operate broiler breeding in the region to select the most suitable region in terms of energy consumption.

MATERIALS AND METHODS

The Tigris basin is one of the largest basins not only in Turkey but also the Middle East. The basin has about 5.500 km catchment area within the borders of the country. Therefore, the Tigris Basin was selected as the study area. The Tigris Basin consists of Diyarbakır, Batman, Siirt, Sirnak and Mardin cities. The map showing the Tigris Basin is given in Figure 1.

Figure 1. Map of Tigris Basin

The annual outdoor dry-bulb thermometer temperatures for a long period of five cities in the Tigris Basin were obtained from the Turkish State Meteorological Service. As a production period of broiler breeding takes an average of six weeks, basic temperature values were determined for six-week periods in Table 1 (Lindley and Whitaker, 1996; Atilgan et al., 2012; Anonymous, 2013; Anonymous, 2015). Heating and cooling degree-days were determined for each province in the study area using 6 different base temperature values given in Table 1.

Table 1. Recommended weekly base temperature for broiler chicken

Weeks	Base Temperature (^{o}C)
1	31
2	27
3	25
4	23
5	21
6	18

Heating and cooling degree-days are defined as the sum of the positive differences between a base temperature and the average daily outside dry-bulb temperature for a certain period (weekly, monthly and annual) time (Eto, 1988). The number of heating and cooling degree-days can be determined using following equation 1 and 2; (Satman and Yalcinkaya, 1999; Buyukalaca et al., 2001; Krese et al., 2012; Yucel et al., 2014; Aydin et al., 2015; Erturk et al., 2015)

$$\text{For } (T_O < T_b),\ HDD = \sum_{i=1}^{n} (T_b - T_O) \quad (1)$$

$$\text{For } (T_O > T_b),\ CDD = \sum_{1}^{n} (T_O - T_b) \quad (2)$$

Where HDD and CDD are the cumulative sum of the heating and cooling degree-days for n days, n is the total number of days in the period, T_b is the base temperature recommended for the broiler chicken and T_o is the mean outdoor air temperature, These equation indicates that only positive values are summed.
Total Heating Degree Day Value (HDDV) and Cooling Degree day Value (CDDV) can be determined using following equation 3 and 4; (Buyukalaca et al., 2001; Yucel et al., 2014)

$$HDDV = \sum_{i=1}^{n} HDD \quad (3)$$

$$CDDV = \sum_{i=1}^{n} CDD \quad (4)$$

Where:
- n is the total number of days which were HDD and CDD during the selected period.

RESULTS AND DISCUSSIONS

Heating degree-day values for each city in the study area were prepared for six base temperature values. Outdoor dry-bulb thermometer temperature values of these provinces were used. A production period of broiler breeding takes an average of six weeks in our country.

The total heating and cooling degree-day values for each city were calculated by correlating the proposed base temperature values of these weeks with outdoor temperature values in the study area. Based on the proposed six base temperature values, the highest heating degree-day values were determined in Sirnak province, and the least heating degree-day values were determined in Batman province. Cooling degree-day values were calculated in the same way (Figure 2). The most cooling need was in Mardin province, except the base temperature value proposed for the first week.

The least cooling day values were in Sirnak province. It can be said that the more the balance temperatures in agricultural buildings in any region are, the less the heating and cooling energy needs of that area will be.

Hence, if the number of heating and cooling degree-days is low in a region, then it can be said that the region is the most suitable location or area for agricultural production.

In accordance with the data obtained in the study area, it was concluded that Batman was the most suitable province for broiler breeding in terms of both heating and cooling degree-days.

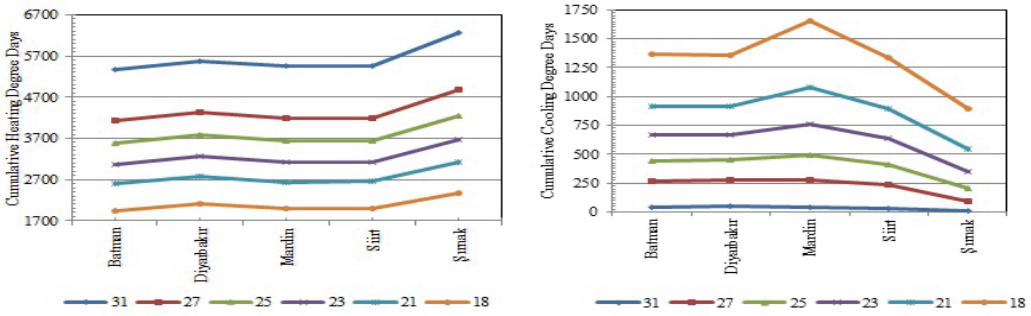

Figure 2. Heating and cooling degree-days according to the base temperature values (°C)

The number of annual average heating and cooling degree-days of the provinces located in the study area were shown in Figure 3. As can be seen from the figure again, the maximum number of average annual heating days was in Sirnak, and the maximum numbers of average annual cooling degree-days were in Mardin province.

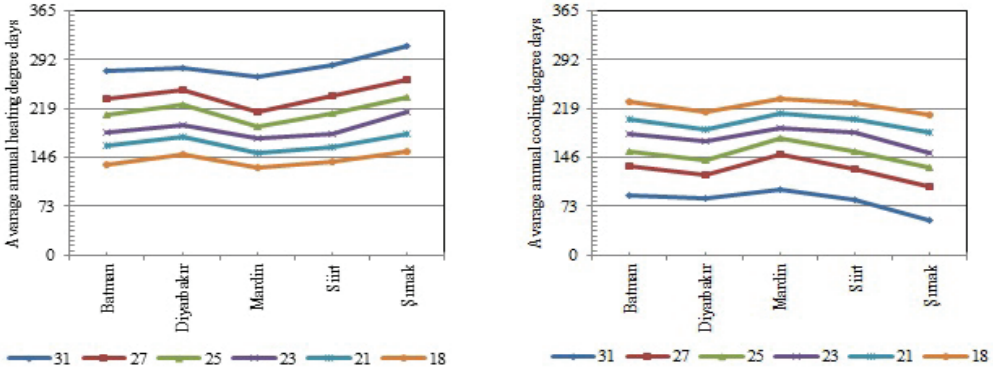

Figure 3. The number of average annual heating degree-days according to the base temperature values (°C)

Regression coefficients were obtained by correlating heating and cooling degree-day values and six proposed base temperature values. It was determined that the regression coefficients for all provinces between cumulative heating and cooling degree-day values (dependent variable) and average annual heating and cooling degree-day values and independent variable, in other words, proposed base temperature values, varied between 0.993-0.999, and there was a very strong relationship in a positive way (Figure 4-5).

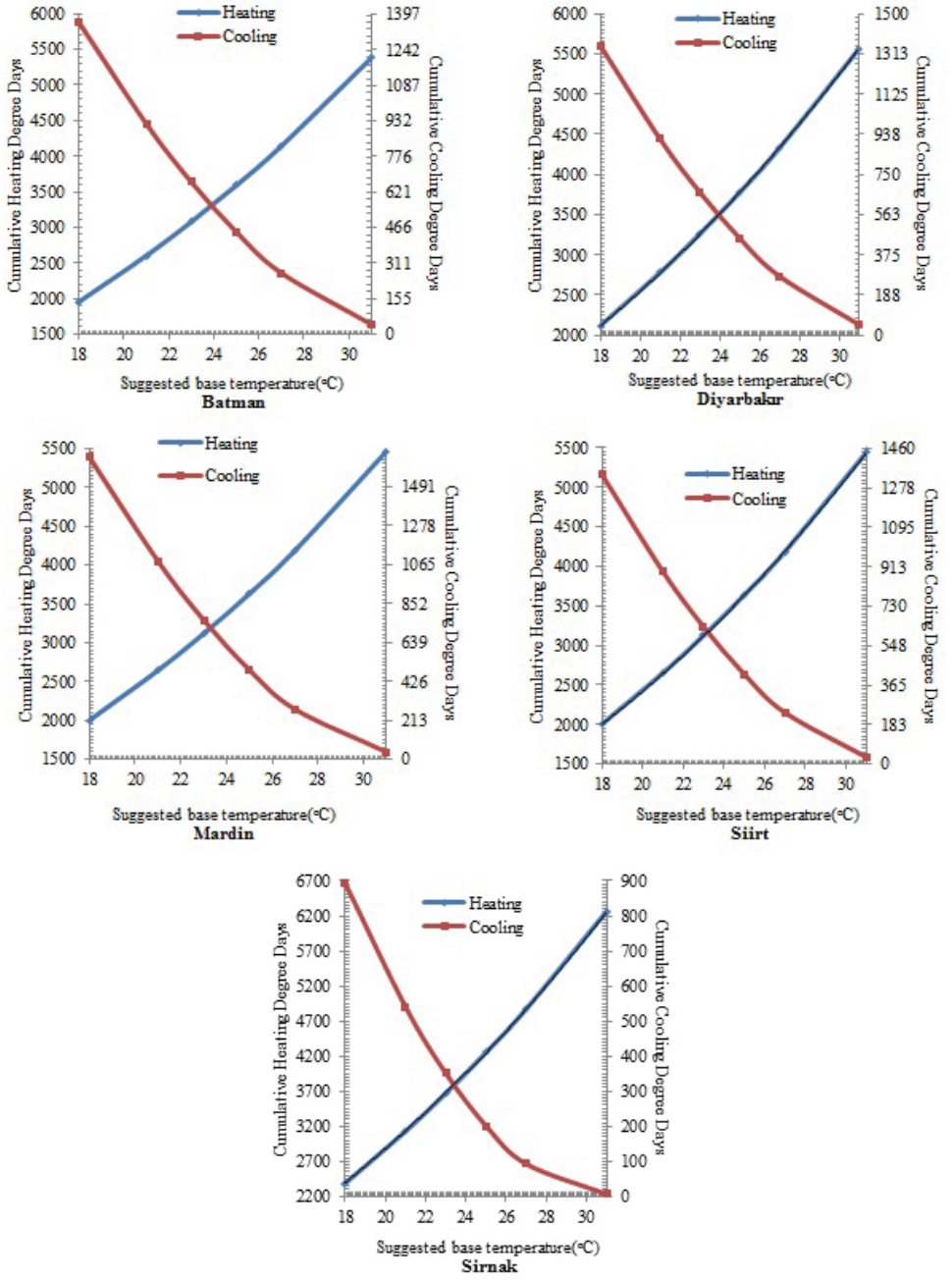

Figure 4. The number of cumulative heating and cooling degree-days according to the base temperature values

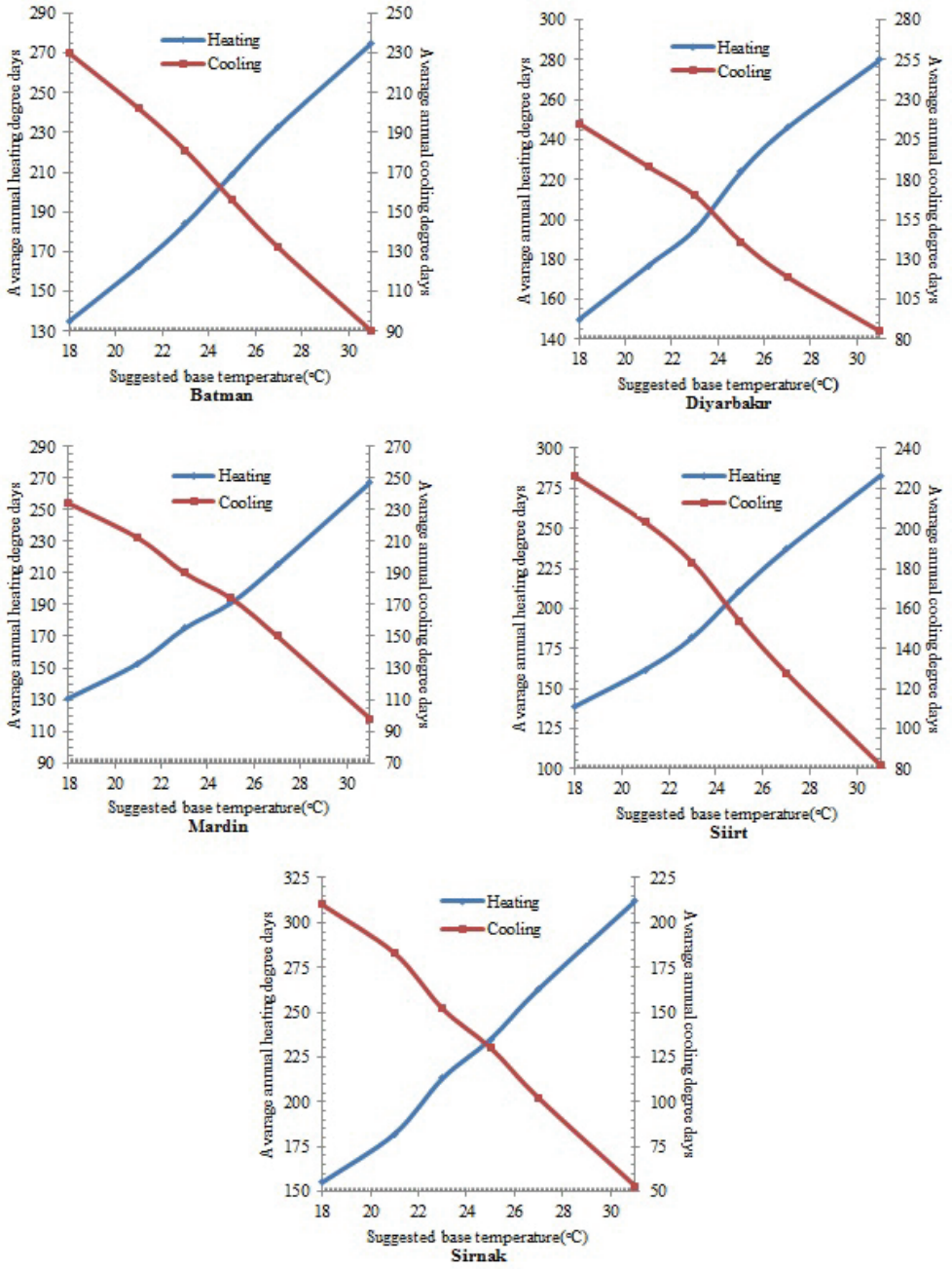

Figure 5. The number of average annual heating and cooling degree-days according to the base temperature values

The researchers reported that prior knowledge on the annual and seasonal heating and cooling energy needs of buildings could be obtained by calculating the degree-day values using the climate data of many years (Duryamaz and Kadioglu, 2003; Erturk et al., 2015).

CONCLUSIONS

The heating and cooling degree-day values based on the six different base temperature values proposed for broiler breeding were determined for five province centers located in

the Tigris Basin based on the daily outdoor air temperature data for the 55-year period. The graphics reflecting the cumulative annual heating and cooling degree-day values and average annual heating and cooling values for six different base temperature points were prepared. The most heating values were in Sirnak Province, and the least heating values were in Batman province. Batman province was determined to be the most suitable province for broiler breeding. In addition, the regression coefficients for all provinces were obtained by correlating heating and cooling degree-day values and proposed six base temperature values, and a very strong relation in a positive way was determined.

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