Morning temperature and humidity compatibility status of dairy cows using temperature humidity index: a case study in Jongbiru village, Kediri regency

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Abstract. The purpose of the study is to observe the status of morning temperature and humidity of the dairy cows’ living environment. The collected data were temperature and humidity measured with dry and wet bulb thermometers. These primary data were processed using THI equation which was specific for dairy cow and classified into six classes based on THI index: (1) comfort; (2) mild discomfort; (3) discomfort; (4) alert; (5) danger; and also (6) emergency. The data then analyzed and explained using descriptive analysis. As a result, the environment’s temperature and humidity were not suitable for the dairy cows. Out of thirty-one observation days, dairy cow suffered 24 times discomfort, six times alert, and twice mild discomfort. The lowest temperature was 22°C while the highest was 26°C. Meanwhile, the minimum humidity value 80% and maximum of 95%. It can be concluded that morning temperature and humidity in the study area were not suitable for the dairy cows.

1. Introduction
The environment’s temperature and humidity directly affect the comfort of livestock life, which will ultimately affect their ability to produce. In the dairy cattle, it will impact on their milk production. Based on a study of weather effect on Scotland’s dairy cattle, it is known that dairy cows suffer lower milk production because of unsupporting temperature and humidity in both outdoor and indoor farming [1]. It was reported that both protein and fat content also decreased because of incompatible weather which effects was more significant when the dairy cattle were reared outdoor than indoor [1].

Both temperature and humidity become major concerns since the upcoming global warming issue, which is indicated by the gradual increase of temperature around the world. As the impact, milk production loss is predicted to be as much as 174±7 kg/cow/decade across America with the most vulnerable area will be in the Southeast for a closer position to the equator than northern area [2]. Friesian Holstein (FH), from the Netherlands, ideally produce 8069 litres/lactation while Indonesian’s Local FH could only produced 3264 litres/lactation if the lactation period ten months or 305 days. As a result, the local dairy cow produces an average of 10.7 litres/lactation if the lactation period ten months or 305 days. As a result, the local dairy cow produces an average of 10.7 litres/days, less than half from ideal FH (26.46 litres/day), because of environmental factor such as temperature. It was reported that dairy cow had Upper Critical Point (UCP) at 25°C [3,4].

Temperature and humidity, as the environmental factor for livestock, shall be analyzed simultaneously using Temperature Humidity Index (THI) according to several scholars’
recommendations and findings [1, 2, 5, 6]. It was reported that THI is an equation combining humidity and temperature for describing animal comfort. It was also claimed that THI has the same accurate prediction as the measurement of the rectal temperature of lactating FH in the sub-tropical area [5]. Meanwhile, the milk production will be optimum at THI between 35 to 72 with a warning of stress start from 70 to 72 [4, 6]. In contrast, some people still open dairy farming regardless the environmental impact like temperature and humidity. For instance, the temperature in Kediri Regency, including Jongbiru area, is around 23°C to 31°C [7, 9] with an average of around 28°C and 75.5% humidity in the industrial area [8]. It was a higher temperature than previous decades between 1975 to 2010, with 24.8 to 26.1°C [9].

Based on the previous explanation, it can be seen that THI can measure the compatibility environment for dairy farming. However, there is still no information regarding whether Jongbiru area is suitable for dairy farming. Revealing the suitability of temperature and humidity will be the novelty of this study. Therefore, the purpose of the research is focused on THI measurement for dairy cow in Jongbiru Village.

2. Materials and Methods

2.1. Material
The materials used are dry and wet bulb thermometers to measure the environment’s daily temperature and humidity. Data were collected in the morning during the dry season from January 2nd to February 2nd, 2019.

2.2. Method
The method used is descriptive analysis after converting temperature and humidity using THI as recommended by a previous study [1][2][4][5][6] as follows:

\[
THI = (1.8T + 32) - \{ (0.55 - 0.0055RH)(1.8T - 26.8) \}
\]

Where THI is the Temperature Humidity Index; T is the Temperature (°C); and RH is Humidity (%). Then, the THI data were grouped into several conditions [6], which is explained in Table 1:

| Status        | Threshold    |
|---------------|--------------|
| Comfort       | THI<68       |
| Mild Discomfort | 68<THI<72   |
| Discomfort    | 72<THI<75    |
| Alert         | 75<THI<79    |
| Danger        | 79<THI<84    |
| Emergency     | THI>84       |

3. Results and discussions
Jongbiru village is located in Kediri Regency, which has a relatively warm temperature as same as Kediri’s characteristic mentioned before [7-9]. However, the morning temperature during early milking at 4.00 AM assumed a low temperature which is the closest requirement to dairy cow’s comfort zone. On that time, the vasodilatation and sweating because of heat stress are occurred [6]. It was reported that lactating dairy cows started experiencing heat stress after 26°C [10]. The variation between temperature and humidity can be explained using THI. Figure 1 illustrates the THI data during the study.
Based on the line chart in Figure 1, it can be seen that THI reached the lowest point twice (70 on January 4th and 72 on January 12th) which were at mild discomfort status. However, THI reached a peak at almost 78 on January 6th which was an alert situation. On that position, the lowest temperature was 22°C while the highest was 26°C. The humidity was at 80% at the least and hit a peak of 95%.

This situation indicates that the temperature and humidity measured by THI are not suitable for the dairy farming. It is because the morning time should give the lowest temperature for dairy cattle since it needs a relatively colder temperature to produce milk efficiently. For accurate description, Table 2 describes the THI Status Summary recorded at a dairy farm in Jongbiru.

Table 2. Summary of THI Status recorded Jongbiru Village

| Status         | n  | % from Total |
|----------------|----|--------------|
| Alert          | 6  | 19%          |
| Discomfort     | 24 | 75%          |
| Mild Discomfort| 2  | 6%           |
| Total          | 32 | 100%         |

As mentioned in Table 2, dairy cows mostly experienced discomfort for 24 times or 75% from the whole months while mild discomfort hit the least 6% or twice. The dairy cows suffered alert situations six times in the entire month of study. Based on this situation, the dairy cows is not suitable to life in this area. Regardless this condition, some dairy farms still run business in Jongbiru Village due to the demand for milk and the lack of competitor in Kediri area. However, there are two option that can be proposed to face the situation: (1) change the dairy breed or (2) environmental engineering.

For the breed changing, the farmer can use stronger dairy cattle like Sahiwal. However, the respond of the milk factory and government are still unknown. Having genetic selection for stronger cow against heat stress is also suggested [2].

Having environmental engineering will bring extra cost but feasible. It can mean either managing housing, adding trees for shade, installing additional ventilation, or even adding air conditioning. Because of the cost of production of environmental engineering, the farmer should be wiser to pick which one is the best for their business.

4. Conclusion
It can be concluded that morning temperature and humidity in the study area was not suitable for the existing dairy cows. It is due to the morning temperature did not meet with the requirement of the dairy cows.
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