# THE EFFECT OF TEMPERATURE HUMIDITY INDEX (THI) ON EGG PRODUCTION IN PRADU-HANGDUM CHAING MAI HIGH EGG PRODUCTION STRAIN CHICKENS

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## Abstract:

The purpose of this research was to study the effects of climate changes on egg production under Chiang Mai Livestock Research and Breeding Center in Chiang Mai Province. This study was conducted from 300 Pradu-Hangdum Chiang Mai high Egg Production strain chickens. The data record collected from April 2019 until March 2020. The study indicated that, the weather was hot and humid. The temperature ranged from 22.28-31.23°C and humidity range were 46.70-81.80%. The highest temperature in May (31.12°C) and April (31.23°C) the lowest temperature in December (22.28°C). Daily temperature and humidity data from meteorological measurements in Chiang Mai were recorded daily over the duration of the trial period were used to calculate the temperature humidity index (THI). The THI group for effect on egg production composition was set to 4 groups (THI1 is THI ≤ 70, THI2 is ≤ 74 THI > 70, THI3 is ≤ 78 THI >74 and THI4 is THI > 78). The highest THI values (THI 4) effect on age at first egg (AFE), THI4 (144.59 day) was lower than THI1 (161.40 day), THI2 (158.22 d) and THI3 (156.17 d). AFE in summer season was lower than raining season. The correlation between TEP270 and average egg at 1 mouth (AEM) traits were found the highest correlation (0.90). Moreover, the correlation between weight at first egg (HWFE) and age at first egg (AFE) was 0.38, it meaning that HWFE resulting in AFE faster.

**Keywords**: Temperature humidity index (THI); Egg production; Pradu-Hangdum Chiang Mai high Egg Production strain

## Introduction

Thailand is located in area hot weather conditions are associated with animal production capability. Especially in hot summer and rainy season, high humidity will affect the body temperature of chickens (Amnuay *et al.*, 2011). Higher temperatures and humidity are effected of the environment caused by heat stress directly affects the decline in egg production. The impact is increasing and can survive for a long time. The body temperature of hen is maintained 40.0-42.2 °C by thermoregulatory mechanism when the environmental temperature is within the thermoneutral zone poultry are homoeothermic. If the thermoregulation mechanism is insufficient to maintain homeothermy, the body temperature begins to rise and eventually cause to death from heat stress (Ilker & Simsek, 2013). The upper critical temperature for chickens were between 36 and 37°C are most comfortable. Health, productivity is maximized and stress is minimized at the thermoneutral zone.

Growth rate and egg production of the native chickens under conventional rearing system in villages are very low. During the past several decades, importation of exotic breeds have increased risk of extinction (Shahram *et al.*, 2012). Haiping *et al.* (2011) report the age at first egg is one of the direct indicators for sexual maturation in female chickens. Moreover, Wuttigrai *et al.* (2014) reported mean of age at first egg (day) on Pradu Hangdum chickens was 203 day and Suchittra *et al.* (2015) reported mean of age at first egg (day) on Chee native chickens was 211 day. Egg production is an important economic characteristic in the poultry industrial (Wuttigrai *et al.*, 2014). Nowadays, Thai native chickens have relatively low egg production. From the report found that native chickens was 3-5 sets of eggs each year, 13 eggs each set (Pin *et al.*, 2004). Jennarong *et al.* (2014) studying Thai native chicken in Pradu-Hangdum Chiang Mai using the pure lines of Pradu-Hangdum Chiang Mai under Chiang Mai Livestock Research and Breeding Center and evaluation genetic parameter on egg production. The goal for breeding and selection provide Pradu-Hangdum Chiang Mai high Egg Production strain chickens.

The temperature humidity index (THI) is an indication of the calculation form environmental temperature and humidity caused by heat stress conditions. Therefore, temperature and humidity variation may affect behavioral changes and physiology of the hens. The resultant heat stress comes from the interactions among air temperature, humidity, radiant heat and air speed, where the air temperature plays the major role. Laying hens can produce more number and more big eggs in indoor environmental temperature between 13-24 °C (Ilker & Simsek, 2013). The effect of heat stress on chickens found high mortality, decreased feed intake, low laying rate, egg weight in laying hens (Oguntunji & Alabi, 2010; Mutibvu *et al.*, 2017; Cicero *et al.*, 2018).

The objective of this study was to determine effects of temperature humidity index (THI) on egg production in Pradu-Hangdum Chiang Mai high Egg Production strain chickens.

## Materials and Methods

Animal and egg production data, the study was conducted from 300 Pradu-Hangdum Chiang Mai high Egg Production strain chickens under the open house with battery cages system in Chiang Mai Livestock Research and Breeding Center, SanPaTong District, Chiang Mai Province. The width and length of cages are width × length × high were 20×30×40 cm. All chickens were fed by raised in battery cages; solitary confinement has an artificial mating pattern.

The analysis of climate changes (temperature humidity index; THI) on egg production in Pradu-Hangdum Chiang Mai high egg production Strain Chickens was focused. This study useds data recorded data of individual egg production, include hen weight at first egg (HWFE), age at first egg (AFE), egg weight at first (EWF), average egg weight at 270 day (AEW270), total egg production at 270 day (TEP270) and average egg at 1 mouth (AEM).

Meteorological measurements in Chiang Mai were recorded daily over the duration of the trial period (Average temperature: degree Celsius) and Relative humidity (Average humidity: percentage). According to the method of (Mutibvu *et al.*, 2017). The data record collected from April 2019 until March 2020.

The temperature and relative humidity data (from April 2019 until March 2020) obtained from the records of the meteorological center closest to each meteorological measurements in Chiang Mai. The weather information included daily temperature and relative humidity recorded every 3 h, which were used to calculate the temperature humidity index (THI) by using the equation bellow (Mader *et al.*, 2006).

$$THI = T_d - [0.55x(RH/100)] \ x \ [T_d - 58]$$

Where $T_d$ is temperature in degrees Celsius and RH is relative humidity as a percentage. After calculating the THI value dividing the THI group into 4 groups as follows: THI1 is THI ≤ 70, THI2 is ≤ 74 THI > 70, THI3 is ≤ 78 THI >74 and THI4 is THI > 78.

***Statistical analysis***

The means of egg production traits were analyzed using PROC MEANS (SAS, 1998). The correlation among production traits used PROC CORR. The effect of THI on egg production traits was performed using the GLM procedure. The means between variables were considered significantly different at P < 0.05 (SAS, 1998).

## Results and Discussion

Table 1 shows the means, standard deviation (SD), minimum and maximum for egg production characteristics of Pradu-Hangdum Chiang Mai high Egg Production Strain Chickens. This study showed the means of hen weight at first egg (HWFE) was 1,930.87 g. Moreover, means of age at first egg (AFE), egg weight at first (EWF), average egg weight at 270 day (AEW270), total egg production at 270 day (TEP270) and average egg at 1 mouth (AEM) were 153.81 day., 33.80 g., 44.80 g., 137.92 egg, 16.33 egg, respectively. According with Worawit *et al.* (1998) reported mean of weight at first egg of hen was 1,900 g. which similarly with this study. But, Wuttigrai *et al.* (2014) reported mean of age at first egg (day) in Pradu Hangdum chickens was 203 day. and accordance with Pin *et al.* (2004) reported mean of egg weight at first in Betong chickens was 38.53 g. and Natthakan (2015) reported mean of egg weight at first in black-bone chicken was 35.14 g.

**Table 1:** The descriptive data of egg production in Pradu-Hangdum Chiang Mai high egg production strain chickens.

| Traits | Means | SD | Minimum | Maximum |
|---|---|---|---|---|
| HWFE | 1,930.87 | 19.35 | 1,075.00 | 2,482.00 |
| AFE | 153.81 | 11.75 | 128.00 | 198.00 |
| EWF | 33.80 | 5.94 | 18.00 | 58.00 |
| AEW270 | 44.80 | 3.05 | 32.28 | 54.36 |
| TEP270 | 137.92 | 28.76 | 70.00 | 211.00 |
| AEM | 16.33 | 3.04 | 8.67 | 23.44 |

Note: $^{ab}$means within a row with different superscripts different significant (P<0.05)
HWFE is hen weight at first egg (g), AFE is age at first egg (day), EWF is egg weight at first (g), AEW270 is average egg weight at 270 day, TEP270 is total egg production at 270 day, AEM is average egg at 1 mouth

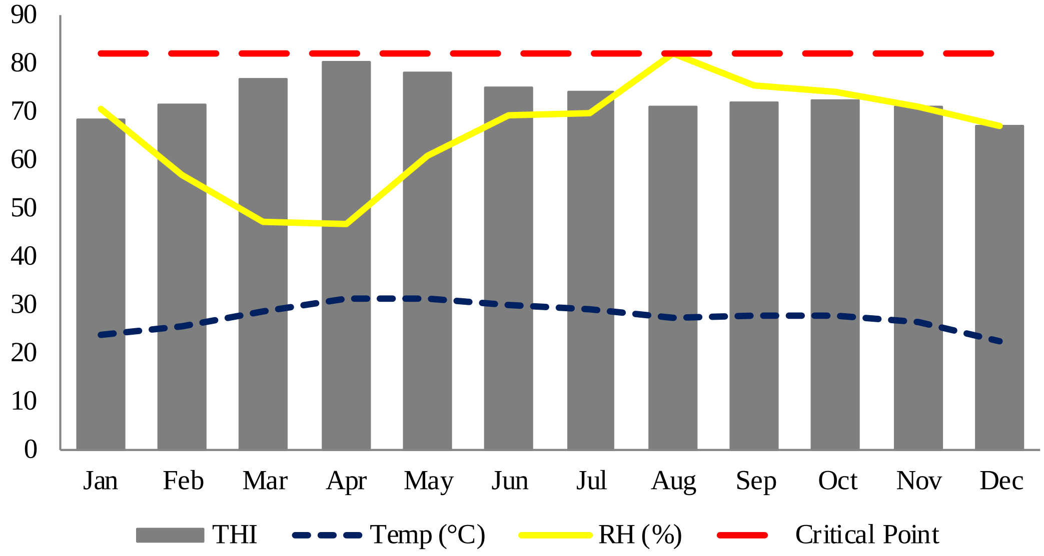


**Figure 1:** Average temperature, relative humidity and temperature humidity index (THI) variation during year of 2019.

Figure 1 shows temperature, relative humidity, temperature humidity index (THI) and critical point that can affect chickens due to heat stress. The highest temperature add THI found on April. Moreover, the temperature and THI values in this study were lower than 80 which had on effect on egg production. Habeeb *et al.* (2018) showed critical point that can affect productivity in chickens due to heat stress when THI over 82.

**Table 2:** Environmental conditions during the experimental periods.

| Month | Temperature (°C) | | | Relative humidity (%) | | | THI |
|---|---|---|---|---|---|---|---|
| | Means | Minimum | Maximum | Means | Minimum | Maximum | |
| January | 23.73 | 21.10 | 26.10 | 70.30 | 64.00 | 89.00 | 68.25 |
| February | 25.33 | 23.30 | 27.00 | 56.70 | 49.00 | 67.00 | 71.48 |
| March | 28.54 | 26.20 | 31.20 | 47.10 | 40.00 | 52.00 | 76.80 |
| April | 31.23 | 28.90 | 33.40 | 46.70 | 40.00 | 60.00 | 80.45 |
| May | 31.12 | 27.30 | 34.70 | 60.90 | 43.00 | 82.00 | 77.96 |
| June | 29.67 | 27.40 | 32.70 | 69.10 | 58.00 | 83.00 | 74.99 |
| July | 28.97 | 24.50 | 32.70 | 69.70 | 56.00 | 92.00 | 74.12 |
| August | 27.37 | 24.90 | 29.20 | 81.80 | 67.00 | 91.00 | 70.80 |
| September | 27.77 | 25.40 | 29.50 | 75.30 | 66.00 | 85.00 | 72.05 |
| October | 27.81 | 24.50 | 29.80 | 74.00 | 66.00 | 90.00 | 72.27 |
| November | 26.15 | 24.60 | 28.20 | 71.00 | 64.00 | 80.00 | 70.84 |
| December | 22.28 | 17.70 | 25.40 | 67.20 | 49.00 | 78.00 | 66.89 |

Table 2 shows of temperature, relative humidity and temperature humidity index (THI) by Meteorological Department from Chiang Mai province. Mean maximum and minimum of temperature, relative humidity and calculated THI by the experimental period are shown in table 2. There are 3 seasons in Thailand: winter season (October to January), summer season (February to May) and raining season (June to September). The highest temperature (31.23), THI (80.45) and lowest humidity (46.70) was found on April which in summer season.

The effect of temperature humidity index (THI) of all 4 groups on egg production in Pradu-Hangdum Chiang Mai high Egg Production Strain Chickens was found in AFE. The AFE trait on THI4 (144.59 day) was lower than THI1 (161.40 day), THI2 (158.22 d) and THI3 (156.17 d). For means of HWFE, EWF, AEW270, TEP270 and AEM among THI groups were not significant difference (Table 3). Narongsak (2004) reported the upper critical temperature for chickens was between 36 and 37°c is most comfortable. Health, productivity is maximized and stress is minimized at the thermoneutral zone. Habeeb *et al.* (2018) showed critical point that can effect chickens due to heat stress when THI over 82. Therefore, the AFE of THI4 in maximum at 80.45 shows that THI4 is still in a comfortable range of animals.

**Table 3:** The effected of THI groups on egg production in Pradu-Hangdum Chiang Mai high egg production strain chickens.

| Traits | THI groups | | | | P-value |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| HWFE | 1,935.00 | 1,991.37 | 1,938.55 | 1,868.16 | 0.83 |
| AFE | 161.40[a] | 158.22[a] | 156.17[a] | 144.59[b] | <0.01 |
| EWF | 32.47 | 34.47 | 34.25 | 32.345 | 0.48 |
| AEW270 | 45.97 | 43.95 | 44.65 | 45.68 | 0.09 |
| TEP270 | 146.80 | 134.28 | 135.89 | 144.67 | 0.39 |
| AEM | 17.14 | 16.42 | 16.16 | 16.59 | 0.79 |

Note: [ab]means within a row with different superscripts different significant (P<0.05)
HWFE is hen weight at first egg (g), AFE is age at first egg (day), EWF is egg weight at first (g), AEW270 is average egg weight at 270 day, TEP270 is total egg production at 270 day, AEM is average egg at 1 mouth.
Temperature humidity index: THI1 is THI ≤ 70, THI2 is ≤ 74 THI > 70, THI3 is ≤ 78 THI >74 and THI4 is THI > 78.

**Table 4:** Egg production (LSM ± SD) between summer and rainning in Pradu-Hangdum chiang Mai high egg production strain chickens.

| Traits | Seasons | | P-value |
|---|---|---|---|
| | summer | raining | |
| HWFE | 1,839.70 | 1,934.01 | 0.33 |
| AFE | 138.40[b] | 154.34[a] | 0.01 |
| EWF | 31.98 | 33.86 | 0.10 |
| AEW270 | 45.32 | 44.78 | 0.18 |
| TEP270 | 148.90 | 137.54 | 0.47 |
| AEM | 16.74 | 16.31 | 0.41 |

Note: [ab]means within a row with different superscripts different significant (P<0.05)
HWFE is hen weight at first egg (g), AFE is age at first egg (day), EWF is egg weight at first (g), AEW270 is average egg weight at 270 day, TEP270 is total egg production at 270 day, AEM is average egg at 1 mouth
Summer is February to May, raining is June to September, Winter is October to January

Table 4 shows egg production (LSM ± SD) of the different seasons in Pradu-Hangdum Chiang Mai high Egg Production Strain Chickens. For the effect of seasons, AFE in summer was the best is significant different. For HWFE, EWF, AEW270, TEP270 and AEM was no significant different in the seasons (P<0.05). Narongsak (2004), the genetic potentiality of poultry would not be utilized fully. The main season for this restriction is environment constraints. In accordance with Behura *et al.* (2016) reported summer at means temperature was 31.71°C, so age at first egg is summer in chickens (138.40 day). Because of influence from the environment found that the hot weather makes the chicken stay comfortable. Housing system effect on the thermos physiological traits of hens by higher in battery cage than the deep litter system. Narongsak (2004) showed a comfortable temperature for chickens was between 36 °C and 37°C in the summer.

**Table 5:** The correlation of egg productions in Pradu-Hangdum Chiang Mai high egg production strain chickens.

| Traits | HWFE | AFE | WFE | AEW270 | TEP270 | AEM |
|---|---|---|---|---|---|---|
| HWFE | 1.00 | 0.38 | 0.18 | 0.07 | -0.17 | -0.12 |
| AFE | | 1.00 | 0.25 | -0.16 | -0.07 | -0.02 |
| EWF | | | 1.00 | -0.12 | -0.06 | -0.04 |
| AEW270 | | | | 1.00 | 0.07 | 0.01 |
| TEP270 | | | | | 1.00 | 0.90 |
| AEM | | | | | | 1.00 |

Note: HWFE is hen weight at first egg (g), AFE is age at first egg (day), EWF is egg weight at first (g), AEW270 is average egg weight at 270 day, TEP270 is total egg production at 270 day, AEM is average egg at 1 mouth

Table 5 shows the correlation of egg productions in Pradu-Hangdum Chiang Mai high Egg Production strain chickens. The correlation on egg productions between -0.17 to 0.90. The result showed correlation between TEP270 and AEM traits was the highest correlation (0.90). The highest correlation of this study showed that, the chickens high TEP270 and high AEM also. A positive correlation was found between HWFE and AFE (0.38) and between AFE and EWF (0.25). In addition, HWFE was negatively correlated with TEP270 (-0.17). Moreover, the correlations between AFE and AEW270 was negatively relationship (-0.16). In accordance with Oke *et al.* (2004) reported percentage lean was positive correlated with body weight and weight at first egg. Moreover, Hidalgo *et al.* (2011) reported percentage lean was positive correlated with age at first egg and egg weight. But, age at first and egg production, weight at first egg and egg production were negatively correlated.

## Conclusions

Results of this study indicate the effect of temperature humidity index (THI) on egg production in Pradu-Hangdum Chiang Mai high Egg Production strain chickens**.** The AFE trait on THI4 (144.59 day) was lower than THI1 (161.40 day), THI2 (158.22 d) and THI3 (156.17 d). For HWFE, EWF, AEW270, TEP270 and AEM among THI groups not significant difference. AFE in summer season was lower than raining season. The correlation between TEP270 and AEM traits was found the highest correlation (0.90).

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