THE EFFECTS OF TEMPERATURE, PESTS, NECTAR-PRODUCING PLANTS, AND LOG SIZE ON TRIGONA Sp. BEE HONEY PRODUCTION IN SOUTH TANGERANG, BANTEN PROVINCE, INDONESIA

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ABSTRACT

Honey is a natural product produced by bees that collect nectar from plants the raw material (forage), which were sucked and collected, then processed and stored in the bee hives. The cultivation of stingless bees that produce honey will be successful when the environment is very supportive by providing many flowers and nectar-pollen-producing plants, as well as other sufficient food resources. Inappropriate temperature and annoying pests will destroy the bee colonies. This research, which observed the number of honey production from Trigona sp. bees, aimed to study: 1) The number of the average honey production per log, and 2) The effects of temperature, pests, nectar-producing plants, and log size on Trigona sp. bee honey production. The data of the Trigona sp. bee honey production were processed and analyzed using quantitative analysis through multiple linear regression. The equipments used were the Microsoft Excel software and the Stastitical Product Service Solution (SPSS) version 2.1. Total revenue produced by Trigona sp. bee honey was IDR 10.178.400/year. Total income per log was IDR 282.733/year. Test t indicated that the log size, nectar-producing plants, and pests significantly influenced the honey production. Test F indicated that nectar-producing plants, the log size, resin-producing plants, temperature, and pests significantly influenced the Trigona sp. bee honey production.

Keywords: Trigona sp., Production, honey, log size, nectar-producing plants, pest
INTRODUCTION

Honey is a natural product produced by bees that collect nectar from plants the raw material (forage), which were sucked and collected, then processed and stored in the bee hives. The cultivation of stingless bees that produce honey will be successful when the environment is very supportive by providing many flowers and nectar-pollen-producing plants, as well as other sufficient food resources. Inappropriate temperature and annoying pests will destroy the bee colonies. Alexandra et al. (2017) stated that the rising temperature affected the decrease of bee population, which were related to the decrease of honey production. Agussalim, 2015 found that Trigona sp. was economically potential in bee cultivation to produce honey, propolis, and bipollen. Longowska et al (2016) found that the increased honey production was affected by the increased temperature in the end of spring and summer seasons. Switanex et al. 2017 found the death of bee colonies in winter season could be caused by complex interaction of some factors, such as parasites, bee-hive management, chronic stress, pesticide, and complete habitat. The increased temperature and global radiation were related with the increased mortality. However, the temperature in November and February was the exception. Tosi et al. (2004) found that the heat can reduce honey quality and diastase number and increase hydroxymethylfultural content. Gomez diego et al. (2009) stated that the viscosity value of honey in the hives decreased with the increasing temperature. Chong KY, Chin NL, and Yusof YA (2017) revealed that thermosonication was the effective alternative technique for honey processing. Hasan (2015) studied the impact of heating and storage conditions on the diastase number, invertase number, and hydroxymethylfutral (HMF) in three types of Iraqi honey and found that the heat did not influence the number of diastase and invertase in honey, except the effect of storage time. Therefore, a good and precise management and establishment is necessary to cultivate the honey bee. Indonesia honey production is only reaching 2,000 tons/year with honey per capita consumption that is still low, i.e. 10 until 15 gram/person/year or equivalent to a table spoon per person per year. Compared with honey consumption in sophisticated countries such as Japan and Australia, whose production is reaching 1,200 until 1,500 gram/person/year (Dirjen BPDASPS, 2013). Rumah Kompos (House Compost) is the research centre possessed by The State Islamic University (UIN) Syarif Hidayatullah, Jakarta.
Formulation of Research Problems

From the research background, the formulation of research problems studied are as follows:

1. Are nectar-producing plants, resin-producing plants, log size, temperature and pests influencing *Trigona sp.* honey production?

2. Which variables that are most influencing *Trigona sp.* honey production?

Research Objectives

From the formulation of research problems above, research objectives achieved are as follows:

1. The influence of nectar producing plants, resin-producing plants, log size, temperature and pests on *Trigona sp.* honey production.

2. Variables that most influence *Trigona sp.* honey production.

RESEARCH METHOD

Research Location

Research was located at Rumah Kompos (*House Compost*), State Islamic University (UIN) Syarif Hidayatullah Jakarta [Rumah Kompos UIN Syarif Hidayatullah Jakarta], Cempaka Putih, Ciputat Timur, Tangerang Selatan, Banten. This research was conducted in February – May, 2017. This location was selected to observe the production of *Trigona sp.* bee in the city because this species is originally the forest commodity.

Types and Sources of Data

Data used in this research were primary and secondary data, obtained through the observation in *Rumah Kompos*. Secondary data obtained from the Agriculture Service (*Dinas Pertanian*), the Indonesian Meteorological, Climatological and Geophysical Agency (*BMKG*), various literatures from books, papers, journals, and online articles.

Data Collection Methods

The author collected data and information through:

1. Observation by conducting direct observation of the objects studied in this research. In this case, direct observation at *Rumah Kompos* UIN Syarif Hidayatullah, Jakarta.
2. Literature Study by collecting data and information through various relevant literatures related to the subject in this research, obtained from books, Dinas Pertanian, BMKG, Central Statistic Agency (BPS), related departments, online sources, and others.

**Revenue**

Revenue is the total amount of income generated by the sale of goods or outputs.

- Total Revenue (TR) is the total amount of income generated by the sale of outputs.
  \[
  TR = P \times Q
  \]
  Where : \( P \) = Price
  \( Q \) = Quantity

- Average Revenue (AR) is the income per unit generated by the sale of outputs.
  \[
  AR = \frac{TR}{Q} = \frac{P \times Q}{Q} = P
  \]
  Thus, \( AR = P \)

**The Analysis of Multiple Linear Regression of Analysis**

Multiple Linear Regression is used to analyze the influence of more than one independent variable towards dependent variables. The equation of multiple linear regression is as follows:

\[
Y = a_0 + bX_1 + bX_2 + bX_3 + bX_4 + bX_5 + e
\]

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Y</th>
<th>Output</th>
<th>Liter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>X1</td>
<td>Nectar-producing Plants</td>
<td>Trees</td>
</tr>
<tr>
<td>X2</td>
<td>Log Size</td>
<td>( Dm^3 )</td>
<td></td>
</tr>
<tr>
<td>X3</td>
<td>Resin Plants</td>
<td>Trees</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td>Temperature</td>
<td>( Celsius )</td>
<td></td>
</tr>
<tr>
<td>X5</td>
<td>Pests</td>
<td>Cluster</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>The Influence of Errors or Residuals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Analysis of Multiple Linear Regression was carried out to study the influence of independent variables towards dependent variables, conducted in this research through:
Hypothesis Test of Partial Correlation (t-Test)

The Partial hypothesis test used t-Test, i.e. the test of the significant influence of independent variable towards dependent variables individually. The Significance test is the procedure to determine the sample outputs can either accept or reject Ho, based on the value of statistic test obtained from the data.

The procedure of the t-Test is as follows (Agus Widarjono, 2007):

1. Define nil hypothesis (Ho) and alternate hypothesis (Ha)
2. Calculate t with the formula, as follows:
   \[ t_{	ext{hitung}} = \frac{(\hat{b}_i - \hat{b})}{S_b} \]

Where:
   \( b_i \) = Independent coefficient in-i
   \( b \) = the value of nil hypothesis
   \( S_b \) = Standard deviation of independent variables in-i
3. Define critical value t through table t with df = nk and specific \( \alpha \)
4. Determine to accept or reject Ho, based on the comparison of t-count and t-table (critical value).
   If: \( t \text{ count} > t \text{ table} \), thus Ho rejected and Hi accepted
   \( t \text{ count} < t \text{ table} \), thus Ho accepted and Hi rejected

Hypothesis Test of Simultaneous Correlation (F-test)

Simultaneous test used F-test to simultaneously examine the influence of all dependent variables towards dependent variables.

The procedure of F-test is as follows:
1. Define nil hypothesis (Ho) and alternate hypothesis (Ha)
2. Calculate F-count with the following formula:
   \[ F = \frac{R^2 / (k - 1)}{(1 - R^2) / (n - k)} \]

Where:
   \( R^2 \) = Coefficient of determination
   \( k \) = The number of independent variables
   \( n \) = The number of samples
3. Define critical value (F table); df (k-1, n-k). Where k = the number of parameters, including the intercept.
4. Define to either accept or reject Ho, based on the comparison of F count and F table.
   - If: F count > F table, thus Ho rejected and Hi accepted
   - F count < F table, thus Ho accepted and Hi rejected

**Coefficient of Determination (R²)**

According to Gujarati (1995), coefficient of determination is the formula to define the contribution percentage of independent variables towards dependent variables. The percentage value of the all independent variables influence towards the value of dependent variables is determined through the coefficient of determination of regression equation (R²). The value of the coefficient of determination is ranging from nil to one. The closer the coefficient of determination value to nil, the smaller the influence of all independent variables towards dependent variables. Otherwise, the closer the coefficient of determination value to one, the bigger the influence of all independent variables towards dependent variables (Algafri, 2000).

**The Definition of Operational**

Nazir (2005) stated that the definition of operational is given to a variable through a specified meaning or activity or to give a necessary operational to measure the variables. The definition of operational used in this research:
1. Production is total production obtained in a harvest time, defined by Liter.
2. The number of plants that yields nectars is the number of plants yield nectars around the logs.
3. The size of Log is the log measurement used as nest, defined by dm³.
4. The number of plants yields resin is the number of plants around the logs that yields resin.
5. Temperature is the degree of temperature in logs, defined by Celcius.
6. Pest is the number of animals interfere or decrease the production process of *Trigona sp.* bee honey.

**RESULTS AND DISCUSSION**

**Income Analysis of *Trigona sp.* bee honey**

This research used 37 bee-box-hives (logs), with harvest time once in 4 months. The expenses included: wages, flowers, and bottles.
Table 2. The yield of honey production, price, and expenses of honey production

<table>
<thead>
<tr>
<th>Total Production of Honey</th>
<th>Average production of honey per log</th>
<th>Price of Trigona sp. honey</th>
<th>Total expense of honey production</th>
</tr>
</thead>
<tbody>
<tr>
<td>5294 ml</td>
<td>143ml</td>
<td>IDR 800.000</td>
<td>IDR 70.000/log</td>
</tr>
</tbody>
</table>

Total cost spent in the production of Trigona sp. bee honey is:

\[ TC = 37 \times \text{IDR}70.000 = \text{IDR} \ 2,590,000 \]

Total production expenses spent is IDR 2,590,000, total revenue is:

\[ \frac{143 \text{ ml}}{1000 \text{ ml}} \times \text{IDR} \ 800.000 = \text{IDR} \ 114,400/\text{log} \]

IDR 114,400 is the total revenue of each log in every 4 months. Total in a year is IDR 114,400 x 3 = IDR 343,200/\text{log}

If multiplied by the total number of logs IDR 343,200 x 37 = IDR 12,698,400

Nett profit resulted from the production of Trigona sp. bee honey:

Income = Gross profit – Total Cost
\[ = \text{IDR} \ 12,698,400 – \text{IDR} \ 2,520,000 \]
\[ = \text{IDR} \ 10,178,400 \]

Total income yielded by the production of Trigona sp. bee honey in Rumah Kompos UIN Jakarta is IDR 10,178,400/year. Income for each log is IDR 282,733/year.

The Analysis of Factors influencing the Production of Trigona sp. bee honey

The instrument of multiple regression with the assumption of five factors was used to study the factors that influence the honey production in Rumah Kompos UIN Jakarta. The influence of factors such as the nectar-producing plants, log size, resin plants, temperature, and pest is assumed to influence the production of Trigona sp. bee honey UIN Jakarta.

The Results of Multiple Regression Analysis of Factors Influence the Production of Trigona sp. Bee Honey UIN Jakarta
Table 3. Analysis Results of Multiple Regression of Factors Influence the Production of *Trigona sp.* UIN Jakarta

<table>
<thead>
<tr>
<th>No</th>
<th>Factors</th>
<th>Regression Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nectar-producing Plants</td>
<td>0.376</td>
</tr>
<tr>
<td>2</td>
<td>Log Size</td>
<td>0.099</td>
</tr>
<tr>
<td>3</td>
<td>Resin Plants</td>
<td>0.045</td>
</tr>
<tr>
<td>4</td>
<td>Temperature</td>
<td>0.656</td>
</tr>
<tr>
<td>5</td>
<td>Pets</td>
<td>-0.668</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>122.93</td>
</tr>
</tbody>
</table>

Note: Predicted interval 90%

The Multiple regression equation was made based on the output of the table 4 above to determine the factors that influence the production of *Trigona sp.* bee honey UIN Jakarta, as follows:

\[ Y = 122.93 + 0.376X_1 + 0.099X_2 + 0.045X_3 + 0.656X_4 + -0.668X_5 \]

Through this formula, the constant value 122.93 was obtained, which revealed that IF there is no plant that produces nectars, log size, resin plants, temperature, and pests, THUS the production of *Trigona sp.* bee honey UIN Jakarta is 122.93 ml.

**The Test of Single Regression Parameter**

T-test with level of confidence 90% (\( \alpha = 0.1 \)), variable independents (number of flowers, log size, trees) significantly influences the production of *Trigona sp.* bee honey UIN Jakarta. This test was carried out to compare \( t_{\text{count}} \) and \( t_{\text{table}} \) (“accepted” if \( t_{\text{count}} < t_{\text{table}} \) or “rejected” \( \text{Ho} \) if \( t_{\text{count}} > t_{\text{table}} \)) or the probability (sig < \( \alpha \)).

**Ho**: There is no influence of independent variables towards the production of honey

“Rumah Kompos” UIN Jakarta

**H1**: There is no influence of independent variables towards the production of honey

“Rumah Kompos” UIN Jakarta
Table 4. The Results of t-Test

<table>
<thead>
<tr>
<th>No</th>
<th>Factor</th>
<th>T_count</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nectar-producing Plants</td>
<td>1,405</td>
<td>0,017</td>
</tr>
<tr>
<td>2</td>
<td>Log Size</td>
<td>1,412</td>
<td>0,068</td>
</tr>
<tr>
<td>3</td>
<td>Resin-producing Plants</td>
<td>0,144</td>
<td>0,086</td>
</tr>
<tr>
<td>4</td>
<td>Temperature</td>
<td>0,420</td>
<td>0,678</td>
</tr>
<tr>
<td>5</td>
<td>Pests</td>
<td>-1,827</td>
<td>-0,077</td>
</tr>
<tr>
<td></td>
<td>Ttable</td>
<td></td>
<td>1,305</td>
</tr>
</tbody>
</table>

The Test of Simultaneous Significance (Statistic Test F)

The test of simultaneous significance (statistic test F) in this research is used to define independent variables included in models (nectar-producing plants, log size, resin plants, temperature, and pests), which simultaneously influence dependent variables (production). This test can be done by comparing the $F_{\text{count}}$ and $F_{\text{table}}$ or from the comparison of probability (Sig with $\alpha$).

With the conditions:

H0 : rejected, if $F_{\text{count}} > F_{\text{table}}$, specific degrees of freedom or Sig < $\alpha$
H1 : accepted, if $F_{\text{count}} < F_{\text{table}}$, specific degrees of freedom or Sig > $\alpha$

Table 5. Table of ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regresion</td>
<td>1251.413</td>
<td>5</td>
<td>250.283</td>
<td>2.816</td>
<td>.033</td>
</tr>
<tr>
<td>Residual</td>
<td>2755.344</td>
<td>31</td>
<td>88.882</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4006.757</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Production
b. Predictors: (Constant), Pests, Nectar-producing Plants, Temperature, Log Size, Resin Plants

The test of simultaneous significance (test F) with level of significance 90% obtained $F_{\text{count}}$ value 2.81 and $F_{\text{table}}$ value 2.01, with significance value 0.033. It can be concluded that H1 accepted ($F_{\text{count}} > F_{\text{table}}$; Sig < $\alpha$), it means that nectar-producing plants, log size, resin plants, temperature,
pest influence the production of *Trigona sp.* bee honey in *Rumah Kompos* UIN Jakarta, simultaneously and statistically.

**Coefficient of Determination (R2)**

The test of coefficient of determination (R2) is used to test the influence of nectar-producing plants, log size, resin-producing plants, temperature, and pests explains the production of *Trigona sp.* bee honey in *Rumah Kompos* UIN Jakarta.

**Table 6. Table of Coefficient of Determination**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.559&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.312</td>
<td>.201</td>
<td>9.428</td>
</tr>
</tbody>
</table>

The test of multiple regression obtained the value of coefficient of determination (R2), i.e. 0.312, it means that 31.2% of the production of *Trigona sp.* bee honey *Rumah Kompos* UIN Jakarta can be explained by the factors of nectar-producing plants, log size, resin-producing plants, temperature, and pests. Meanwhile, the remains, i.e. 68.8% can be explained by the other related factors, such as worker, humidity, post-harvest, rainfall, and others.

**CONCLUSION AND SUGGESTION**

**Conclusion**

Based on the research that was done for 4 months, it can be concluded that total income obtained from the production of *Trigona sp.* bee honey *Rumah Kompos* UIN Jakarta, i.e. IDR 10,178,400/year. The factors that influence the production process of *Trigona sp.* bee honey *Rumah Kompos* UIN Jakarta are: nectar-producing plants, log size, temperature, and pests, with income per log IDR 282,733/year. The F-test obtained five factors that are simultaneously influencing honey production and can be used to predict the production of *Trigona sp.* bee honey *Rumah Kompos* UIN Jakarta. The test of coefficient of determination 31.2% of the production of *Trigona sp.* bee honey *Rumah Kompos* UIN Jakarta can explain those five factors.

**Suggestion**

Through this research, the author gives suggestions to improve *Rumah Kompos* UIN Jakarta in achieving maximum production, as follows:
1. To maintain the log size and manage the pest control in the production of *Trigona sp.* bee honey, as well as to innovate the production activities.

2. To increase the number of nectar-producing plants such as flowers and resin-producing plants that produce sap, and to maintain the temperature in logs in achieving the maximum production of *Trigona sp.* bee honey.

3. To maximize the other factors that influence the production of *Trigona sp.* bee honey, such as worker, humidity, the number of bees in log, the harvest and post-harvest management, and other factors.
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