Estimation and Correlation of Surian Leaves (Toona Sinensis) Weight with the Tree Parameters

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Abstract. Leaves of surian tree (Toona sinensis) based on the research, can be used for medications, such as diabetes, cancer, and others. At the present the people is being switched from chemical drugs to herbal medicines. Therefore, surian leaves is one source of herbal medicine to be developed in the future. However, information of leaves biomass in each tree relating to ages and tree parameters is unknown. This study aims to determine the weight of surian leaves on each tree and to examine the relationship of leaves weight with several tree parameters. The study was conducted on private forests in Sumedang District. The sample of 110 trees were taken purposively. Tree parameters were measured, namely: Diameter Breast Height (DBH), total height, timber height, crown height, crown diameter, age, and leaves weight of each tree. The results of the correlation analysis showed that there was a significant relationship between four parameters of the tree, namely DBH, total height, crown height, and crown diameter with surian leaves weight. The highest correlation with the weight of surian leaves is DBH, amounting to 0.75. Estimated weight of leaves in DBH 10-19 cm is 8-11 kg/tree. Whereas for DBH above equal to 20 cm is 18-23 kg/tree.

1. Introduction

Surian (Toona sinensis) trees are commonly found in private forests in West Java Province. So far, the benefits and utilization of the tree are taken from the wood only. The price of the wood is indeed higher than that of the sengon or fast growing species commonly planted in community forests. Nowday, many studies have tested the benefits of surian leaves [1,2,3,4,5]. Based on these studies, Surian leaves are proven to have a variety of pharmacological activities such as antioxidants, antidiabetic, antihyperlipidemia, and anticancer. The current trend of people to switch from synthetical drugs toward herbal medicines which are believed to have minimum side effects compared to the drugs. Surian leaves is one of the sources of herbal medicine that has the potential to be developed in the future. But to develop drugs from surian leaves raw materials, it is necessary to estimate their availability in nature.

Estimation of surian leaves biomass in each tree needs to be done so that the availability of raw materials is known. It is not easy to estimate leaves biomass from trees that have not yet been cut down. For this reason it is necessary to examine the relationship of leaves weight with various parameters of the stand, without damaging the tree [6,7]. This research will become preliminary data to build a model of the estimation of surian leaves weight. In this paper, what is meant by tree parameter is quantitative data measurements on tree parts such as diameter at breast height, total height, crown diameter, and crown height.
2. Methods
2.1. Study Site
The research location was in the private forest in Cinanjung Village and Mangun Arga Village in Sumedang Regency, West Java Province. Mangun Arga Village has an altitude of +741 m above sea level with coordinates 06°47′59″S 107°47′59″E and Cinanjung Village has a height of +910 m above the sea level with coordinates ranging from 06°55′11″S 107°48′05″E. In detail the position of the study site area can be seen in Figure 1.

![Study Site Area](image1.png)

Figure 1. Study Site Area

2.2. Data Collection
Data was collected from 110 Surian trees selected by purposive sampling [8, 9, 10] in community forests. The trees were selected based on age distribution and diameter at breast height (DBH). The measured DBH is above 10 cm. Whereas the age found in the field ranged in age from 7 to 34 years.

For each tree, data collection and measurement of tree parameter [11, 12, 13] which are estimated to have a relationship with leaves weight are carried out as follows:

- diameter at breast height (DBH),
- total height (TH),
- timber height (TiH),
- crown height (CH),
- crown diameter (CD).

Surian leaf data is collected by climbing trees and trimming them. Next the leaves are weighed, which is the weight of the wet leaves.

![Parameters of Tree](image2.png)

Figure 2. Parameters of Tree
2.3. Data Analysis

2.3.1. Correlation among Variables

Correlation among variables measured against the weight of surian leaves was obtained using Pearson correlation [14, 15, 16, 17]. The Pearson correlation formula is as follows:

\[
\rho_{xy} = \frac{n \sum_{i=1}^{n} x_i y_i - \left( \sum_{i=1}^{n} x_i \right) \left( \sum_{i=1}^{n} y_i \right)}{\sqrt{\left( n \sum_{i=1}^{n} x_i^2 - \left( \sum_{i=1}^{n} x_i \right)^2 \right) \left( n \sum_{i=1}^{n} y_i^2 - \left( \sum_{i=1}^{n} y_i \right)^2 \right)}}
\]

Where,
\[
\rho_{xy} = \text{Pearson r correlation coefficient between x and y} \\
n = \text{sample size} \\
x = \text{weight leaves (kg/tree)} \\
y = \text{variables tree parameter} = \frac{TT}{TiT}
\]

The coefficient correlation value ranges from 0 to 1, in which the greater value showed the significantly relationship between the two variables. The category of relationship among variables according to the closeness of correlation given the benchmark as in Table 1:

| Correlation Coefficient | Categorical |
|-------------------------|-------------|
| = 0.20                  | Very weak   |
| > 0.20 – 0.40           | Weak        |
| >0.40 – 0.70            | Moderate    |
| >0.70 – 0.90            | Strong      |
| > 0.90                  | Very strong |

2.3.2. Estimation Leaves Weight of Trees

There are several stages in determining the estimated leaves weight of each tree. The analysis is performed using the formulas as follows:

- Mean of leaves weight per tree

\[
\bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i
\]

- Variance of leaves weight per tree

\[
s^2 = \frac{1}{n-1} \left( \sum_{i=1}^{n} y_i^2 - \frac{\left( \sum_{i=1}^{n} y_i \right)^2}{n} \right)
\]

- Average variance of leaves weight per tree

\[
S_y^2 = s^2
\]

- Average standard error of leaves weight per tree

\[
S_y = \sqrt{s_y^2}
\]
• Estimate interval weight of leaves per tree
  \[ \bar{y} \pm t_{(\alpha/2,n-1)}s_{\bar{y}} \]  

\[ (6) \]

• Sampling error (\%)
  \[ SE(\%) = \left( \frac{t_{(\alpha/2,n-1)}}{\sqrt{n}} \right) \times 100\% \]  

\[ (7) \]

In where,
  \( y_i \) = variable leaves weight per tree
  \( n \) = size of sample
  \( t_{(\alpha/2,n-1)} \) = t table student, with \( \alpha \) and free degree (n-1)

3. Result and Discussion

3.1. Correlation among Tree Parameters

The six parameters of the tree were compared in this study. The relationship can be seen in Table 2. The strongest correlation between variables is between Total Height (TH) and Crown Height (CH) with coefficient value 0.83. While the lowest correlation is found in the relationship between leaves weight and Timber Height (TiH) with value 0.1.

Table 2. Correlation coefficient of tree parameters

| Variables | Leaves Weight | DBH  | TH   | TiH  | CH   | CD   |
|-----------|---------------|------|------|------|------|------|
| Leaves   | 1             | 0.751*** | 0.528** | 0.101 | 0.533** | 0.527** |
| Weight   | DBH           | 0.751*** | 1     | 0.692** | 0.317** | 0.573** | 0.601** |
|          | TH            | 0.528** | 0.692** | 1     | 0.452** | 0.832** | 0.396** |
|          | TiH           | 0.101 | 0.317** | 0.452** | 1     | -0.119 | 0.438** |
|          | CH            | 0.533** | 0.573** | 0.832** | -0.119 | 1     | 0.170 |
|          | CD            | 0.527** | 0.601** | 0.396** | 0.438** | 0.170 | 1  |

***. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

1. The correlation between DBH variable and leaves weight of a surian tree exhibit high correlation with the coefficient value of 0.75. This correlation shows a strong relationship. Scatter plot of each variable from each sample can be seen in Figure 3. In Figure 3 the linear trend lines on each variable relationship varies. The higher determinant value (R2) indicates that the dependent variable (leaves weight) can be predicted by the independent variable. The closeness can be seen in detail in Table 3. It is seen that DBH has the highest R2 value compared to other variables.
Correlation and determinant values in each tree parameters relationship Figure 3 are shown in detail in Table 3. DBH has the most close relationship compared to other parameters, so that by measuring DBH can estimate the weight of a surian leaf. DBH has proven to be a good predictor for many other parameters in one tree, see Table 2 [18,19,20].
Table 3. Determinant and coefficient correlation values of tree parameters with leaves weight

| Variables                        | Determinant (R²) | Correlation (r) |
|----------------------------------|------------------|-----------------|
| DBH - Leaves Weight              | 0.564            | 0.751           |
| Total Heigh - Leaves Weight      | 0.278            | 0.527           |
| Timber Height - Leaves Weight    | 0.007            | 0.084           |
| Crown Height - Leaves Weight     | 0.282            | 0.531           |
| Crown Diameter - Leaves Weight   | 0.070            | 0.265           |

3.2. Estimate Weight of Leaves Surian

Estimation of surian leaves weight averages per tree by sampling method of 110 samples in the field obtained as shown in Table 4. These estimation were divided into 2 classes of DBH, yielding different averages of surian leaves weight per tree.

Tabel 4. Estimate parameter leaves weight based on DBH Class

| Estimate Parameters Leaves Weight | Class Diameter Breast Heigh (DBH) |
|-----------------------------------|----------------------------------|
|                                   | 10-19 cm | 20-45 cm |
| Mean (kg/tree)                    | 9.55     | 20.63    |
| Varian (kg/tree)²                 | 18.19    | 108.20   |
| Standard Error (kg/tree)          | 0.56     | 1.37     |
| Interval Weight Leaves (kg/tree)  | 8.45 – 10.65 | 17.96 – 23.31 |
| Sampling Error (%)                | 11.49    | 12.97    |

At DBH below 20 cm, leaves weight variations are not large between trees. Otherwhile the variation of high weight at DBH> 20 cm occurs. This can be seen from the value of the variance and standard error of the two classes.

In the future when surian (Toona sinensis) leaves have become herbal medicines, the private forest farmers will have additional income besides the wood. Farmers do not need to cut down their trees anymore to get income.

4. Conclusions

- The parameter of the tree which has the highest correlation to the weight of surian leaves is Diameter Breast Height (DBH) with a correlation coefficient of 0.7.
- The estimated leaves weight of each tree is divided into 2 DBH classes, namely the 10-19 cm class, which the estimated leaves weight is 8-11 kg / tree, and the diameter class is 20-45 cm which the estimated weight leaves is 18-23 kg / tree

5. References

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