



Productivity of Vegetable Hummingbird Tree Legumes Seeds or White Turi (*Sesbania grandiflora* L.) by Soaking in Rice Washing Water and Coconut Water

Wahyudi Himawan Sutanto*¹, Rizka Ramadhani², Bayriell Dudeq Opok³

¹Departement of Animal Science, Faculty of Agriculture, Universitas Sumatera Utara, Indonesia

²Departement of Nutrition and Feed Technology, Faculty of Animal Science, Institut Pertanian Bogor, Indonesia

³Faculty of Sustainable Agriculture, Universiti Malaysia Sabah, Sandakan, Sabah, Malaysia

*Corresponding Author: wahyudihimawan@usu.ac.id

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ABSTRACT

Rice washing water and old coconut water are commonly regarded as household waste, despite their potential as sources of nutrients and natural plant growth regulators. This study aimed to evaluate the effect of soaking white turi legume seeds (*Sesbania grandiflora* L.) in rice washing water and old coconut water at different concentrations on seed productivity. The research was conducted in Medan City from February to March 2025 using a Completely Randomized Design (CRD) with five treatments and four replications, namely: control (distilled water), 100% rice washing water, 100% old coconut water, a combination of 20% old coconut water + 80% rice washing water, and a combination of 50% old coconut water + 50% rice washing water. Observed parameters included growth potential, vigor index, plumule length, radicle length, and number of radicle branches. Data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The results showed that soaking seeds in 100% rice washing water and in the combination of 20% old coconut water + 80% rice washing water produced the highest growth potential and vigor index (90%). In contrast, 100% old coconut water resulted in the lowest performance for most parameters, particularly vigor index and radicle length. The greatest plumule length was numerically observed in the 100% rice washing water treatment, while the number of radicle branches did not differ significantly among treatments. In conclusion, rice washing water, either applied alone or combined with low concentrations of old coconut water, can enhance seed productivity and vigor of white turi, indicating its potential use as a natural and environmentally friendly plant growth regulator.

Keywords: Hummingbird Tree or White Turi, Legumes Seeds, Rice Washing Water, Coconut Water, Seed Productivity, Seed vigor, Growth Potential



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1. Introduction

Rice washing water and old coconut water are considered waste that is less profitable for the community so many are simply thrown away. Rice washing water is the water used to wash rice before it is cooked into rice, while old coconut water is the water inside a ripe or old coconut. The nutrients contained in rice washing water are in a sufficient range including 0.03% N; 0.42% P₂O₅; 0.06% K₂O; 0.46% organic C [1] and 14.25% Ca, 2.94% Ca, 0.03% S, 0.04% Fe [2] to support plant growth, so this water can be used as an alternative nutrient

source or additional supplement for plants. Rice washing water contains vitamin B1 which plays a role in the plant's metabolic process to convert carbohydrates into energy that activates plant growth activities [3]. The vitamin B1 content in rice washing water can stimulate faster root growth during the nursery period [2]. Old coconut water has the following composition of growth regulators: cytokinin 5.8 mg/l, auxin 0.07 mg/l, and gibberellin 0.01 mg/L (Muazzinah & Nurbaiti, 2017). In addition, old coconut water is also rich in nutrients such as potassium, minerals including calcium (Ca), sodium (Na), magnesium (Mg), iron (Fe), copper (Cu), and sulfur (S), sugar and protein [4].

Legumes are one of the animal feed plants that have a high protein content of up to 15-30% and are very popular with livestock. One of the legumes that is widely known by the public is the white turi (*Sesbania grandiflora* L.). White turi (*Sesbania grandiflora* L.) is a legume plant from the Fabaceae family and the Faboideae subfamily. This plant is known for its fast growth, deep root system, and high adaptability to tropical environmental conditions (Setiawan, 2018). White turi plants have high nutritional content and bioactive compounds. The leaves contain quite high crude protein (around 20-28%) so that it has the potential as animal feed [1].

The use of natural growth regulators is thought to accelerate germination because it contains hormones that stimulate plant growth. Because of the high nutrient content of rice washing water and coconut water waste, both of which have the potential to be used as natural hormones, it is necessary to conduct a study entitled "Seed Productivity of White Turi Legume (*Sesbania grandiflora* L.) by Soaking in Rice Washing Water and Coconut Water". This study aims to determine the germination productivity of white turi legume seeds by soaking in rice washing water and coconut water with various concentrations and combinations.

2. Materials and Methods

2.1. Time and Location

This research was carried out at Medan City. The research implementation time begins in February-March 2025.

2.2. Materials

The tools and materials used in this research are white turi seeds, seed paper (rice straw paper), old coconut water, rice washing water, distilled water, ruler, caliper, label paper, pen, book, beaker glass, measuring cup, and container for sprouts (thinwall).

2.3. Experimental Design

This study used a Completely Randomized Design (CRD), with 5 treatments and 4 replications. The treatment arrangement was as follows:

T0 = Control (Aquadest)

T1 = Rice washing water 100%

T2 = Coconut water 100%

T3 = Coconut water 20% + Rice washing water 80%

T4 = Coconut water 50% + Rice washing water 50%

2.4. Methodology

This research began with selecting good seeds, such as large sizes without any wrinkles and seeds that had not been stored for long. Treatment is given to the seeds by soaking the seeds in soaking liquid for 2 hours. The coconut water used is coconut water which comes from old coconuts [5]. The rice washing water used is rice washing water taken from the first washing process [6]. While waiting for the soaking process to complete, the next step is to prepare a container for seedlings in which the container is lined with straw paper. Wet the straw paper with water according to each treatment and when the soaking is complete, arrange the seeds into the seedling container. Next, mark the seedling container with the treatment code and close the container, then store it in a shady and dark place. The observation process was carried out on the 4th day after sowing and continued on the 8th day after sowing.

2.5. Growth Potential

Seeds are said to have growth potential if roots grow through the pericarp. Growth potential is expressed as a percentage (%). Growth potential is observed during the first observation (first day count), which is 4 days after sowing, and the last observation (last day count), which is 8 days after sowing. The formula for calculating growth potential is:

$$GP = \frac{\text{The Number of Seeds that Grow}}{\text{Number of Seeds Planted}} \times 100$$

2.6. Vigor Index

The vigor index is calculated based on the number of normal sprouts on the first day of observation (4 days after sowing). The vigor index is used to determine the ability of normal seeds to grow well, strong, and have a normal sprout structure. The formula for calculating the vigor index is:

$$VI = \frac{\sum KN \text{ Observation 1}}{\text{Number of Seeds Planted}} \times 100$$

2.7. Plumule Length, Radicle Length, and Numbers of Radicle Branches

Plumule length is the length of the stem that grows on the seeds that are planted, while the radicle length is the length of the roots that grow on the seeds that are planted, and for the number of radicle branches is the number of root branches that grow on each seed that is planted. Measurements carried out to measure the length of the plumule and the length of the radicle were carried out on the 4th day and the 8th day after planting using a caliper and a ruler and the results were averaged and or combined between the 4th and 8th days. While the process of calculating the number of radicle branches was calculated on the 4th day after planting and the 8th day after planting, the final result was obtained from the average of the number of branches on both days of calculation.

2.8. Data analysis

The data obtained was analyzed using Analysis of Variance (ANOVA). If there is a noticeable difference ($P < 0.05$), then it is followed by Duncan's Multiple Range Test (DMRT).

3. Result and Discussion

3.1 Growth Potential

The capacity of seeds to develop regularly or abnormally under ideal circumstances is known as growth potential. Growth potential is a measure of seed viability, according to [7]. Seeds that have germinated will continue to grow every day. There will be a limit on how far seeds may grow [8]. According to [9], The term "growth potential" describes a plant's innate ability to expand its size, mass, volume, or biomass irreversibly through cell division, enlargement, and differentiation. This ability is mainly fueled by meristematic activity throughout the primary and secondary growth stages. In many species, this potential takes the form of indeterminate growth, which permits ongoing development through apical and lateral meristems under the influence of genetic programming that establishes the maximum dimensions that are possible under optimal circumstances.

Table 1. Growth potential

Treatment	Growth Potential (%)
T0	80
T1	90
T2	75
T3	90
T4	75

Based on the result obtained above, the data show that Treatment 1 (T1), rice washing water (100%) and Treatment 3 (T3), coconut water (20%) + rice washing water (80 %) has the highest percentage of growth potential. As for controlled treatment (T0), it has an 80% of growth potential. On the contrary, Treatment 2 (T2), coconut water (100%) and Treatment 4 (T4), coconut water (50%) + rice washing water (50%) has the lowest percentage of growth potential.

By this, it cannot be denied that rice washing water gives the highest chances for a plant to grow because Vitamins B1 (thiamine), B12, and the minerals N, P, K, and C are among the nutrients found in rice washing water that plants require, according to [10]. Additionally, 85–90% of the carbohydrates in rice washing water come from starch. The production of the hormones auxin, gibberellin, and alanine will be aided by the high carbohydrate content of rice washing water. On the other hand, [6] agrees that coconut water contains cytokinin hormone that can stimulate root growth and development. This statement is also supported by past researchers in their research. That is why T1 and T3 showed excellent growth.

But on the contrary, high concentration of coconut water can inhibit the effect of cytokinin, thus damaging the plant, inhibiting growth and development of shoots [11]. [11] also believed that the cutting material, which is either too young or too old, may also cause that harm. Too-old stems lack natural hormones and carbohydrates, which prevents shoot and root formation, while too-young stems evaporate fast, causing cuttings to deteriorate and perish. Significant leaf and branch deterioration, followed by drying out and dying stems, are the signs. This can support why results for T2 and T4 show a low percentage of growth or low growth potential.

3.2 Vigor Index

According to [12], vigor index or more specifically, seedling vigor index, is a numerical statistic that measures a seed lot's overall physiological quality and potential for field performance by combining germination percentage with seedling growth. However, the physiological state, genetic makeup, and storage circumstances all affect how quickly seeds age. A thriving seed business and the upkeep of a sustainable and productive agriculture depend on the availability of a sufficient supply of crop seeds of consistently good quality. It was discovered that plants grown from high-quality seed yielded 18% more than those grown from low-quality seed. Because high-quality seeds operate as a catalyst for realizing the potential of other inputs, having healthy and robust seeds available at planting time is crucial for reaching agricultural output objectives.

Table 2. Vigor index

Treatment	Vigor Index (%)
T0	75
T1	90
T2	60
T3	90
T4	65

Results in the table above shows the vigor index for the Vegetable Hummingbird Tree legumes seeds (*Sesbania grandiflora L.*). The findings show that seedling vigor among the five treatments, with T1 and T3 attaining the greatest vigor index values of 90%, suggesting better seed quality and the possibility of strong field establishment. T0 (75%), T4 (65%), and T2 fall into a moderate-to-low range, while T2 recorded the lowest at 60%, indicating inadequate performance potentially owing to detrimental treatment effects on

germination or seedling development. According to established Abdul-Baki and Anderson equations, greater indices correspond to improved total physiological strength, demonstrating how therapies can have a major impact on vigor [13].

With both treatments exceeding 90%, T1 and T3 stand out as top performers. This suggests that successful interventions, such as priming, nutrition augmentation or stress mitigation, increased the germination percentage multiplied by seedling length or dry weight. [14] Believed that as a suitable benchmark or baseline, T0 at 75% outperforms T4 (65%) and particularly T2 (60%), which may be the result of inhibitory factors such as severe stress, inadequate storage, or genetic variability that results in weaker seedlings. Plus, with the help of statistical analysis such as ANOVA using variance ($p < 0.05$), coefficients of variation highlighting T2's instability similar to low-vigor strains in multilocation trials.

Due to their high scores, which indicate uniform emergence and better yields under field circumstances, T1 and T3 are preferred for planting. These vigor index results inform practical agricultural decisions. While T4's moderate score indicates possibility for improvement through combination therapies, worse performers like T2 demand inquiry into causal reasons (e.g., seed size, age, or environmental exposure) to prevent deployment hazards. All things considered, the data highlights the vigor index as a trustworthy discriminator that goes beyond simple germination, allowing for the optimization of animal feed crop or forage seed lots in production systems [15].

3.3 Seeds Productivity (Plumule Length, Radicle Length, and Numbers of Radicle Branches)

Table 3. Seeds productivity

Treatment	Plumule Length (cm)	Radicle Length (cm)	Numbers of Radicle Branches
T0	1.17 ± 0.18 ^a	6.00 ± 0.99 ^c	5 ± 1.56
T1	1.83 ± 0.47 ^c	5.42 ± 0.79 ^c	6 ± 3.80
T2	1.35 ± 0.43 ^{bc}	3.02 ± 0.24 ^a	5 ± 1.67
T3	1.42 ± 0.05 ^{bc}	4.65 ± 1.08 ^{bc}	7 ± 1.88
T4	1.41 ± 0.20 ^{bc}	3.80 ± 0.97 ^{ab}	6 ± 2.47

Radicle = Different letters in the same column indicate significantly different ($P < 0.01$).

Plumule = Different letters in the same column indicate significant differences ($P < 0.05$).

Branch = The same letters in the same column indicate no significant difference ($P > 0.05$).

As seen in the table above, the highest plumule length according to numbers was obtained in treatment T1, while according to statistical calculations, the best plumule length was found in T1, T3, T4, and T2. Rice washing water contains plant growth regulators. Plant growth regulators (PGRs) in plants act as stimulants for root and stem growth and the formation of root and stem branches by inhibiting apical dominance (excessive shoot growth) and the formation of young leaves [16].

T0 (6.00 cm, c) had the longest roots in terms of radicle length, followed by T3 (4.65 cm, bc), T1 (5.42 cm, c), and T4 (3.80 cm, ab). T2 (3.02 cm, a) had the shortest radicle. The various letters (a, b, and c) represent statistically significant differences at the selected probability level; treatments with different letters differ substantially from those with the same letter. Root length is widely acknowledged as a "very real" and sensitive indicator of seed vigor and future resource absorption potential, and our data demonstrate that the control (T0) and certain treated seeds (T1, T3) established substantially stronger root systems than T2.

Plumule length varied from 1.17 cm in T0 to 1.83 cm in T1, but all treatments aside from T0 share the same letter group (bc), suggesting that T1–T4 do not significantly differ statistically. Compared to radicle length, plumule length is regarded as a "real" but weaker predictor of treatment effects since these changes are minor and often not significant. In line with research that prioritizes primary root length and total root biomass over straightforward branch counts as vigor descriptors, the number of radicle branches (5–7) is interpreted as "not real" or unreliable in this dataset for differentiating vigor. For example, T2 has 5 branches but poor radicle length, whereas T3 has 7 branches.

3.4 Correlation Between Parameters

Table 4. Correlation between parameters

Parameters	Correlation coefficient	P-value
Growth Potential vs Vigor Index	0.952 **	0.000
Growth Potential vs Plumule Length	0.558 *	0.011
Growth Potential vs Radicle Length	0.447	0.048
Growth Potential vs Radicle Branches	0.356	0.123
Vigor Index vs Plumule Length	0.601 **	0.005
Vigor Index vs Radicle Length	0.421	0.064
Vigor Index vs Radicle Branches	0.318	0.173
Plumule Length vs Radicle Length	0.214	0.365
Plumule Length vs Radicle Branches	0.517 *	0.019
Radicle Length vs Radicle Branches	0.267	0.256

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level

Correlation analysis among germination and seedling growth parameters revealed several significant relationships (Table X). A very strong positive correlation was observed between growth potential and vigor index ($r = 0.952$; $p < 0.01$), indicating that both parameters consistently reflect seed physiological quality. This result suggests that seeds with higher germination potential tend to exhibit greater overall vigor, confirming that these two variables are closely related indicators of seed performance.

Plumule length showed a moderate and significant positive correlation with both growth potential ($r = 0.558$; $p < 0.05$) and vigor index ($r = 0.601$; $p < 0.01$). This finding indicates that shoot elongation is closely associated with seed vigor and may serve as a reliable morphological indicator of early seedling performance. In addition, plumule length was significantly correlated with the number of radicle branches ($r = 0.517$; $p < 0.05$), suggesting a coordinated development between above-ground and below-ground seedling structures.

In contrast, radicle length exhibited weaker and mostly non-significant correlations with other parameters. Although a low-to-moderate correlation was observed between radicle length and growth potential ($r = 0.447$; $p = 0.048$), this relationship was not consistently significant across variables. This suggests that radicle elongation alone may not adequately represent overall seed vigor. The lack of strong association between radicle length and other growth parameters could be attributed to environmental or physiological factors influencing root elongation independently from shoot growth.

Similarly, the number of radicle branches showed no significant correlation with most variables except plumule length. This indicates that root branching may be regulated by different mechanisms and may not directly reflect seed germination performance or vigor index.

Overall, the results demonstrate that growth potential and vigor index are highly reliable and interrelated indicators of seed quality, while plumule length can serve as an additional supportive parameter. Conversely, radicle length and branching characteristics appear to be less consistent indicators of seed vigor under the conditions of this study. These findings highlight the importance of selecting appropriate parameters when evaluating seed quality and early seedling growth.

4. Conclusion

Soaking white turi (*Sesbania grandiflora* L.) seeds in rice washing water and old coconut water significantly affected seed growth potential, vigor index, and early seedling development. The best results were obtained from 100% rice washing water and the combination of 20% old coconut water + 80% rice washing water, which produced the highest growth potential and vigor index, indicating superior seed quality. Correlation analysis revealed a very strong positive relationship between growth potential and vigor index, confirming both as reliable indicators of seed vigor. Plumule length was also significantly associated with these parameters, suggesting its usefulness as a morphological indicator of early seedling performance. In contrast,

higher concentrations of old coconut water reduced seed performance, indicating a potential inhibitory effect. Radicle length and branching showed weak and inconsistent relationships with other variables, suggesting they are less reliable indicators of seed vigor. Overall, rice washing water, alone or combined with low concentrations of old coconut water, is a promising, low-cost, and environmentally friendly natural growth regulator for improving white turi seed performance.

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