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Morphometric Analysis on Sacha Inchi Plants (*Plukenetia volubilis* L.) using Organic Fertilizer Treatment of Chicken Manure

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ABSTRACT

Sacha Inchi is a plant that has economic potential and is worthy of development. This research was conducted to understand the relationship between variables in the treatment of chicken manure liquid organic fertilizer. The research method used in this research was an experimental method on 200 samples of Sacha Inchi plant seeds. The analytical design used in this research is linear regression analysis. Based on the results of linear regression on chicken fertilizer treatment, it is known that the weight variable has an effect on the cocoa bean surface area variable by 51% (moderate), bean weight has an effect on thickness by 53% (moderate), the effect of thickness on bean surface area is 6.5% (weak) and the volume influenced by seed weight is 81% (strong). Thus, increasing the weight of the seeds will increase the volume of the seeds.

Keywords: *weight, thickness, surface area, seed volume, sacha inchi*

1. INTRODUCTION

The sacha inchi plant, scientifically known as Plukenetia volubilis L., is a remarkable plant that holds great economic potential (Kittibunchakul et al., 2022). Originating from the lush Amazon rainforest in Peru (Chirinos et al., 2013), this plant belongs to the family Euphorbiaceae. Peru takes the lead as the largest producer, yielding an impressive 1200 tons per year (Torres et al., 2023). What makes the sacha inchi plant truly special is its rich nutritional composition. With a staggering 48% oil content and 27% healthy protein, it serves as an abundant source of nourishment. Numerous studies, including those by Gong et al. (2018), Maurer et al. (2018), Muangrat et al. (2018), Wang et al. (2018), and Bondioli & Bella (2014) have highlighted its nutritional value. Not only is the sacha inchi plant packed with nutrients (Cárdenas et al., 2021), (Mhd Rodzi & Lee, 2022), but it also offers various parts that can be utilized for medicinal purposes, as well as in the food industry and other sectors. Its seeds, seed coats, and leaves all possess beneficial properties. Wang et al. (2018) and Eduardo et al. (2019) have extensively explored the diverse applications of these plant components. One notable aspect of sacha inchi is its seeds, which are abundant in omega-3 and omega-6 fatty acids, protein, and antioxidants. This content makes them highly sought after for their health benefits (Kodahl, 2020). The study sheds light on the remarkable properties of these seeds. In conclusion, the sacha inchi plant is a true marvel of nature, offering not only economic potential but also a wealth of nutrition and health benefits (Kodahl, 2020), (Eduardo et al., 2019). Its versatility and sustainability make it a valuable asset to the food industry and beyond.

The growth and development of Sacha inchi plants are crucial due to their numerous benefits and roles. To ensure the sustainable progress of these plants, one effective approach is to enhance production through fertilization. Fertilization plays a vital role in boosting plant productivity by providing essential nutrients and materials to the soil (Fathoni et al., 2020). In the cultivation of Sacha inchi plants, organic fertilizer is utilized to avoid any residues that may be produced by inorganic fertilizers, which could potentially affect the soil or the nutritional content of the seeds. By incorporating organic matter from various sources like manure and compost of crop residues, the soil's organic matter can be increased, soil structure can be improved, and soil saturation can be strengthened (Zhang et al., 2005), (Li et al., 2010). Among the organic materials that can be utilized, chicken manure stands as a viable option.

Dani et al., (2021) research demonstrated that the utilization of chicken manure in conjunction with PGPR had a significant influence on the yield of shallot plants. Similarly, Shafira et al. (2022) study revealed that the application of 20 tons/ha of manure combined with biofertilizer at a concentration of 20 ml/l of water resulted in substantial melon yields. Additionally, Sabran et al. (2015) research reported that the application of 12 tons/ha of chicken manure had a notable effect on the yield of peanut plants.

However, the impact of applying chicken manure on enhancing the productivity of Sacha inchi plants remains unknown. Consequently, the objective of this investigation is to assess the effects of organic fertilizer derived from chicken manure on the seed weight, area, and thickness of Sacha inchi brownish seeds. These variables are crucial as they directly influence the yield and quality of plant oil, which is of utmost importance in the subsequent processing and sales stages. Furthermore, the findings of this study can serve as valuable recommendations for farmers engaged in Sacha inchi cultivation.

2. MATERIAL AND METHODS

Research Location

The investigation took place in Cikadu Sindangkerta, West Bandung, West Java

Province, Indonesia, situated at $6^0$59'46" S $107^0$24'19" E. The research activities were initiated in March 2023. The study involved the utilization of tools and materials designed for Sacha inchi cultivation, as well as liquid organic fertilizer (POC).

Experimental Design

Fertilization of Sacha inchi plants was conducted according to the prescribed treatments and their respective doses. The fertilizer utilized was liquid organic fertilizer derived from chicken manure, known as POC. Specifically, 100% chicken manure was used for the liquid organic fertilizer applied at the research site, with a 150 ml per liter dosage of water. The fertilization regimen involved applying the liquid organic fertilizer every two weeks by circulating it around the Sacha inchi plant (on a plate) through an Internet of Things-based system. This system served as a valuable tool in supporting the research by enabling efficient and accurate monitoring of the fertilization process.

Data Collection Procedure

a. Sample Preparation

Samples were taken from the population of sacha inchi seeds harvested in each chicken manure liquid organic fertilizer treatment. The total number of samples was 200 seeds.

b. Data Collection and Observation of Length and Surface Area of Sacha Seeds Inchi

The seed samples were systematically organized based on their sequence code, with each set containing 25 seeds. A scale was included as a point of reference for accurate measurements. To capture digital images of the seeds, a wireless HP Scanner 415 was utilized. The obtained image data was subsequently processed using the Axio Vision 4.8 application. In order to ensure precise measurements, the image size was calibrated by converting pixel values to the corresponding values on the reference scale. The calibrated seed images were then analyzed to determine their longest and perpendicular lengths. Additionally, observations were made regarding the length and surface area of the seeds in their unpeeled state, with the cocoa bean shell still intact.

c. Data Collection and Observing Seeds Thickness of Sacha Inchi

All samples (N=200) were measured for seed thickness using a calliper and documented in the research notes.

d. Data Collection and Observing Seeds Weight of Sacha Inchi

All samples (N=200) were measured for seed weight with a weighing scale with an accuracy of 0.05 and documented in the research notes.

e. Calculation of Sacha Inch Seed Volume Data

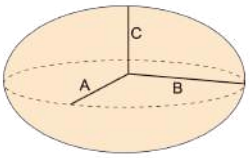

Figure 1. Ellipsoid

Volume is the result of calculations assuming an ellipsoid shape using the formula Volume $4/3 \times \pi \times A \times B \times C$

f. Analysis Design

The final step of this study involves performing regression analysis to examine the correlation between variables in the liquid organic fertilizer treatment of chicken manure. This analysis includes determination analysis and Spearman rank analysis in cases where the data is not normally distributed. The determination analysis is used to test the coefficient of determination, which assesses the model's ability to explain how the independent variable influences the dependent variable. The adjusted R-squared value is used to indicate this relationship (Maidarti et al., 2022). The coefficient of determination ranges from 0 to 1, with values closer to 1 indicating that the independent variable provides most of the information needed to predict the dependent variable. Therefore, a higher R-squared value suggests a better predictive model for the research. Hair, J. & Alamer (2022) categorized the R-squared value as strong if it exceeds 0.67, moderate if it is above 0.33 but below 0.67, and weak if it is above 0.19 but below 0.33.

The Spearman's rank analysis was performed to determine the Spearman's rank coefficient, which assessed the association between seed weight and cacao seed volume. As the data for the weight and volume of brownish seeds in the chicken fertilizer treatment did not follow a normal distribution, Spearman's correlation test was utilized. The correlation coefficient was

determined and calculated using the SPSS software according to the specified formula:

$$r = 1 - \frac{6\sum d^2}{n^3 - n}$$

Note: R = Coefficient Correlation; d = Rank difference, and n = Sample Size.

Once the correlation coefficient for each parameter and seed weight has been calculated, the subsequent task involves ranking them. This ranking process enables the identification of the parameter that exhibits the strongest association with seed weight. Furthermore, it is also possible to compare the r value and R2 in order to assess the relationship between these two values.

3. RESULT AND DISCUSSION

Relationship between variables in chicken manure liquid organic fertilizer treatment

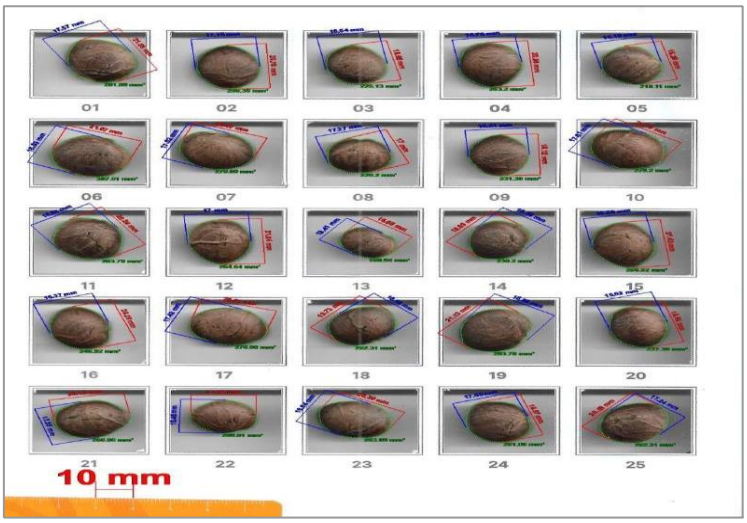

Figure 2. Sample of Sacha Inchi Brownish Seeds Chicken Fertilizer Treatment (PA01-PA25)

Based on the collection of data from 200 seeds of Sacha Inchi administered using fertilizer, descriptive statistics are presented in tabular form.

Table 1. Sacha Inchi Seed Weight in all 4 fertilizer treatments.

Treatment	Average Weight (gram)		Largest Weight (gram)		Smallest Weight (gram)	
	Brownish Seed	White Seed	Brownish Seed	White Seed	Brownish Seed	White Seed
Chicken Manure Fertilizer	1.23±0.30	0.85±0.27	1.56±1.28	1.08±0.83	0.65±0.63	0.27±0.27

Table 2. Surface area of Sacha Inchi seeds.

Treatment	Average Width (rata (mm^2)		Largest Width (mm^2)		Smallest Width (mm^2)	
	Brownish Seed	White Seed	Brownish Seed	White Seed	Brownish Seed	White Seed
Chicken Manure Fertilizer	253.11±0.24	164.42±0.87	307.51±0.54	200.16±0.13	160.94±0.43	87.42±0.10

Table 3. Lengths A and B of Brownish Seeds of Sacha Inchi

Treatment	Average Length (mm)		longest (mm)		Shortest (mm)	
	A	B	A	B	A	B
Chicken Manure Fertilizer	19.77±1.23	16.90±1.23	21.63±0.2	19.08±0.2	15.65±0.23	12.41±0.23

Table 4. Sacha Inchi Seed Thickness

Treatment	Average Thickness (mm)	Thickest (mm)	Thinnest (mm)
	Brownish Seed	Brownish Seed	Brownish Seed
Chicken Manure Fertilizer	8.834±1.2	10.4±9.3	6.6±6.6

Table 5. Ellipsoid calculation volume

Treatment	Average Volume (ml)	Largest Volume (ml)	Smallest Volume (ml)
	Brownish Seed	Brownish Seed	Brownish Seed
Chicken Manure Fertilizer	1.55±1.2	1.96±1.5	0.67±0.6

Based on the findings from the linear regression analysis conducted on the chicken fertilizer treatment, it is evident that the R-squared value in Figure 2a is 0.512, indicating a moderate relationship. This result suggests that the weight variable accounts for 51% of the variation in the surface area variable of the brownish seeds, while the remaining 49% is attributed to other factors. In Figure 2b, the relationship between seed weight and seed thickness is also considered moderate, with an R-squared value of 0.535. These numbers imply that seed weight explains 53% of the variation, leaving 47% to be influenced by other factors. Conversely, Figure 2c displays a weak relationship with an R-squared value of 0.065 regarding the impact of thickness on the surface area of brownish seeds. On the other hand, a strong and positive relationship is observed in the volume, where 81% of the variation is explained by the weight of the seeds, as indicated by an R-squared value of 0.818. The visual representation of the data also confirms a positive trend, showing that an increase in seed weight leads to a corresponding increase in seed volume**.** The findings suggest that the growth of seeds will have an impact on the quantity of content within Sacha inchi seeds, resulting in a higher yield. Sanjuan-Martínez et al. (2020) conducted research that revealed how the physical characteristics of chilli fruits across different species can affect the production of sauces and seasonings. In addition to examining the correlation between seed size and yield, morphometric analysis is also valuable for cultivating diverse varieties. Jesus et al., (2021) discovered through their research on the morphometrics of Papaver somniferum L. subsp. Somniferum provides insights into the historical distribution of this plant in Europe.

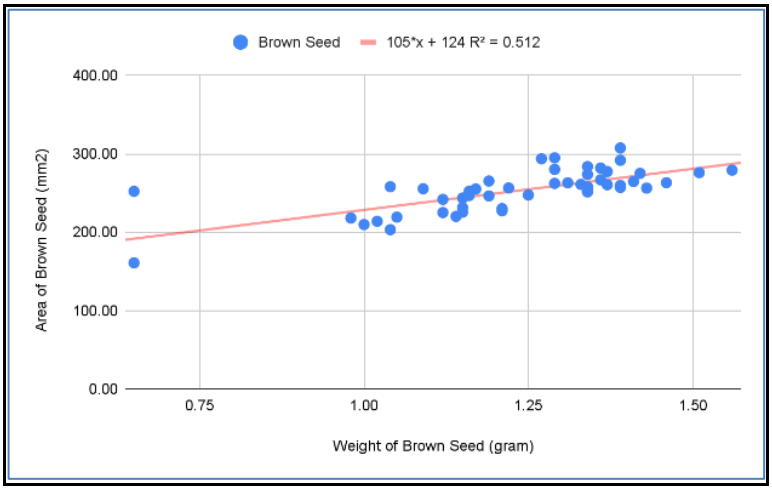

Figure 3. Area of Brown Seed (a)

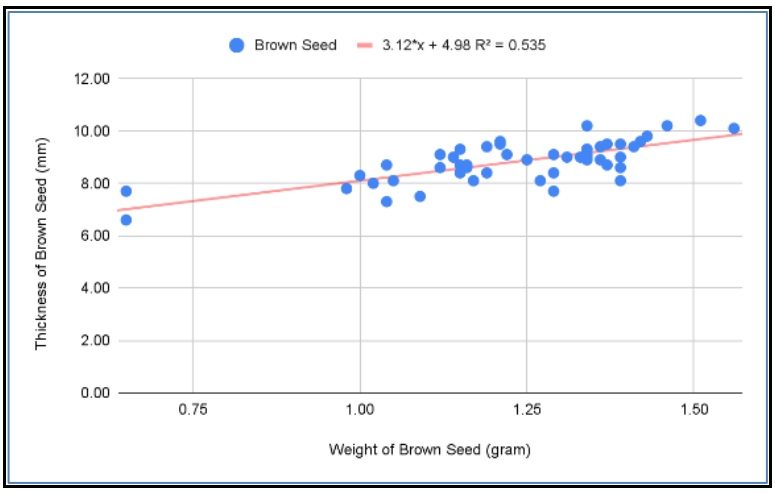

Figure 4. Thickness of Brown Seed (b)

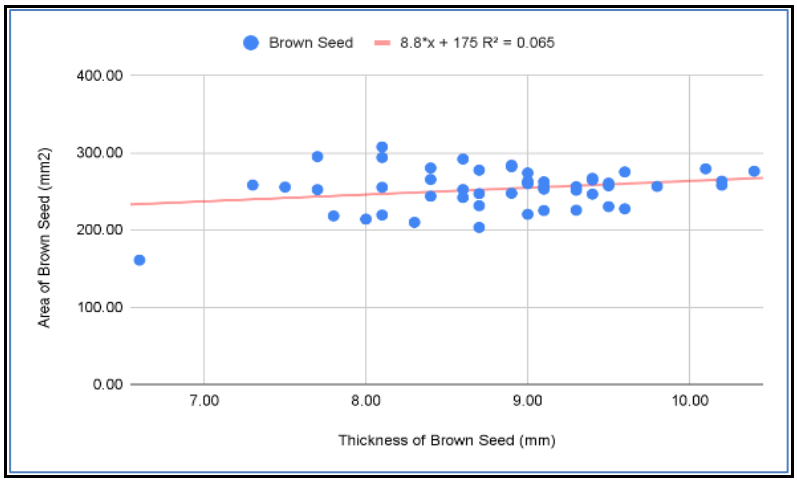

Figure 5. Area of Brown Seed (c)

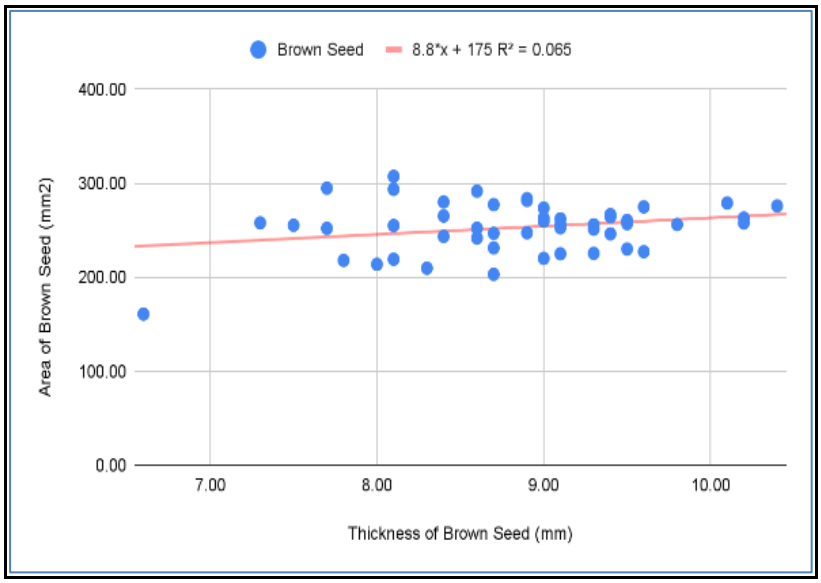

Figure 6. Area of Brown Seed (d)

The data on the weight and volume variables of brownish seeds in the chicken fertilizer treatment did not follow a normal distribution, leading to the conduction of Spearman's correlation test on these two variables. The obtained significance value was 0, which is less than 0.05, indicating a significant relationship between the weight variable and the volume of brownish seeds in the chicken fertilizer treatment. The correlation coefficient value between the weight and volume variables was found to be 0.913, signifying a very strong positive relationship. This positive correlation suggests that an increase in volume is associated with an increase in the weight of brownish seeds, indicating that the two variables move in the same direction. These findings align with the research conducted by Wahyuningtyas & Ardiarini (2020), which also reported a significant correlation between seed characteristics and the total weight of sunflower seeds. Similarly, Krisnawati & Adie (2016) found a positive correlation between morphological and agronomic characteristics with soybean seed yield. Additionally, Karomah et al. (2018) discovered a positive correlation between oil content and seed characteristics in corn plants. Understanding the relationship between different characteristics and yield quality can aid in the direct selection process during plant breeding.

4. CONCLUSION

Based on the conducted discussion, it is evident that the weight variable significantly impacts the surface area variable of brownish seeds by 51% (moderate effect), while bean weight affects thickness by 53% (moderate effect). Additionally, the influence of thickness on bean surface area is relatively weak at 6.5%. Moreover, the volume is strongly influenced by seed weight at 81%. Consequently, an increase in seed weight will result in a corresponding increase in seed volume. This finding will serve as the foundation for processing sacha inchi brownish seeds to produce oil products that offer health benefits.

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