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Increasing Growth and Production of Pagoda Mustard (*Brassica narinosa*) by Giving Coconut Shell Biochar and Jakaba LOF

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Abstract

Pagoda mustard greens (*Brassica narinosa*) are mustard greens characterized by their unique leaf shape, which resembles a pagoda with a crunchy texture and a slightly sweet flavor. This study aims to evaluate the effectiveness of combining coconut shell biochar and Jakaba in enhancing soil fertility, nutrient availability, and the growth and yield of pagoda mustard greens. This study used a factorial randomized block design (RBD). The first factor is the addition of Biochar planting media with 4 levels, namely: 0 g/polybag (Control), 100 g/polybag, 250 g/polybag, 500 g/polybag. The second factor is LOF Jakaba with 4 levels, namely: 0 ml/polybag, 50 ml/polybag, 100 ml/polybag, 200 ml/polybag. and used Duncan's Multiple Range Test (DMRT) analysis. The results showed that the provision of coconut shell biochar and Jakaba significantly affected plant height, fresh weight, and dry root weight of pagoda mustard greens, with the P3A3 treatment showing the best results. In contrast, the number of leaves did not show any significant difference between treatments, which was likely influenced by other factors such as environmental conditions and plant genetics. Using biochar and Jakaba can increase plant growth and development by improving nutrient availability, soil aeration, and the activity of microorganisms that support nutrient absorption.

Keywords: Coconut Shell Biocar, Jakaba, Mustard Greens, Mustard Greens Growth, Mustard Greens Production

1. Introduction

Pagoda mustard greens (*Brassica narinosa*) are a variety of mustard greens characterized by their unique leaf shape, which resembles a pagoda. They possess a crunchy texture and a subtly sweet flavor. This vegetable is rich in nutrients, including vitamins A and C and essential minerals, making it a popular ingredient in cooking, particularly in stir-fries and soups. Pagoda mustard greens have a relatively fast growth cycle and can be cultivated in various environmental conditions, making them an appealing choice for vegetable farmers (Rosyidah, 2022). The main problems in cultivating pagoda mustard greens are soil fertility factors and fertilizer use efficiency. Infertile soil can inhibit plant growth. Soil fertility and efficiency of fertilizer use in cultivating pagoda mustard greens are closely related to plant nutrient needs because plants need sufficient nutrients to support optimal growth and production. Infertile soil tends to lack essential nutrients such as nitrogen, phosphorus, and potassium, thus inhibiting leaf and root growth. Meanwhile, inefficient use of fertilizers can cause nutrient imbalances and less than optimal yields, so it is important to implement the right fertilization strategy according to plant needs. Therefore, innovations such as providing coconut shell biochar and Jakaba are needed to increase water retention and nutrient availability. In addition, suboptimal cultivation techniques can cause low production and increased risk of pest and disease attacks, which affect harvest yields (Sarif, P., Hadid & Wahyudi, 2015).

Oil palm shell biochar is charcoal from the pyrolysis of oil palm shells, which is used as a soil conditioner to increase the fertility of agricultural land (Ramadhan et al., 2024). This biochar has a porous structure that can absorb and retain water and nutrients, thereby increasing the efficiency of fertilization and soil fertility in the long term. In addition, biochar also plays a role in increasing the activity of soil microorganisms that are beneficial for plant growth and help mitigate climate change by absorbing

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carbon from the atmosphere. (Panataria et al ., 2020) It was found that biochar as a soil conditioner can improve soil fertility by increasing permeability, porosity, soil structure, water holding capacity, and cation exchange capacity (CEC) of the soil so that plant roots can grow more easily. The main problem in using oil palm shell biochar is the availability of raw materials and the production process, which requires special technology. The pyrolysis process must be carried out efficiently to produce high-quality biochar without excessive emissions. In addition, the application of biochar in plant cultivation requires the right dosage because excessive use can cause undesirable changes in the chemical properties of the soil, such as a drastic increase in pH, which can inhibit the absorption of nutrients by plants (Pradigta & Firgiyanto, 2021).

The limited absorption of nutrients from inorganic fertilizers is often a problem in plant cultivation because not all nutrients provided can be optimally absorbed by plants. Most nutrients can be lost due to leaching, evaporation, or bound in a form unavailable to plants, especially in soils with poor structure. This causes low fertilizer efficiency, and plants still experience nutritional deficiencies even though fertilization has been carried out, so plant growth and yields are not optimal.

Jakaba (Eternal Lucky Mushroom) is a biological organic fertilizer made from fermented banana stems, known for its ability to increase soil fertility and plant growth. Jakaba contains beneficial microorganisms that help decompose organic matter and increase the availability of nutrients for plants (Meliza, Fedri Ibnusina, 2024). In addition, Jakaba can also increase soil water absorption and improve the structure of less fertile soil, so it is widely used in organic farming as an alternative to chemical fertilizers. The problem with using Jakaba is the fermentation process, which requires optimal time and conditions for the microorganisms to grow well. If fermentation is not carried out properly, the effectiveness of Jakaba as a fertilizer can be reduced, even at the risk of causing pathogens that are detrimental to plants. In addition, because Jakaba is still an innovation in agriculture, further research is still needed to determine the most effective dosage and application method for various types of plants and soil conditions.

Providing coconut shell biochar and Jakaba can potentially increase the growth and production of pagoda mustard greens (*Brassica narinosa*) by improving soil quality. Coconut shell biochar has a porous structure that can absorb and retain water and nutrients, thus supporting the availability of nutrients for plants. Meanwhile, Jakaba, as a biofertilizer, contains beneficial microorganisms that help decomposition organic matter and increase nutrient absorption by plant roots. Combining the two can increase plant height, number of leaves, and weight of pagoda mustard greens harvest. The problem in applying coconut shell biochar and Jakaba is determining the right dose so that the benefits are optimal without causing negative impacts on the soil and plants. Using excessive amounts of biochar can drastically change soil pH, while imperfect Jakaba fermentation can cause an imbalance of microorganisms in the soil. In addition, the availability of raw materials and production processes that require time and certain technologies are challenges for farmers in adopting this innovation widely (Ibnusina, 2024). Research (Wasilah & Bashri, 2019) shows that LOF made from food waste with a concentration of 10.4 ml/L of water provides optimal growth in mustard greens, including plant height and wet biomass.

Based on the background explanation above, the researcher will study the Effect of Coconut Shell and Jakaba Biochar on the Growth and Production of Pagoda Mustard Greens (*Brassica narinosa*). This study aims to examine the effectiveness of the combination of coconut shell and Jakaba biochar in increasing soil fertility, nutrient availability, and the growth and yield of pagoda mustard greens. Thus, the results of this study are expected to provide an alternative agricultural technology that is more environmentally friendly and sustainable for farmers.

2. Material and Methods

2.1. Place and Time

This research was implemented on Jln.Sempurna, Rantau Selatan District, Labuhanbatu Regency. at coordinates 2°06'58.0" N and 99°50'26.0" E, with an altitude of ±43 meters above sea level. This research took place from January to March 2024.

2.2. Tools and materials

The tools needed to make planting media, Biochar, and LOF Jakaba, are shovels, measuring cups, hammers, buckets, gas, gas stoves, spoons, and cloth to cover the container. The materials needed to make planting media, Biochar, and LOF Jakaba are soil, polybags, pagoda mustard seeds, coconut shells, water leri (rice washing), bran, and bamboo roots.

2.3. Research methods

This study used a factorial Randomized Block Design (RAK) with 2 factors. The first factor was the addition of Biochar planting media with 4 levels, namely: 0 g/polybag (Control), 100 g/polybag, 250 g/polybag, 500 g/polybag. The second factor was Jakaba LOF with 4 levels, namely: 0 ml/polybag, 50 ml/polybag, 100 ml/polybag, 200 ml/polybag.

2.4. Observation Parameters

2.4.1. Plant height (cm)

Plant height measurement with observation intervals of 7 days, namely at 14, 21, 28, 35, 42 HST. Plant height is measured from the planting medium's surface to the growing point's tip using a ruler.

2.4.2. Number of Leaves (Shells)

Calculate the number of leaves with an observation interval of 7 days, namely at 14, 21, 28, 35, 42 HST. The leaves counted are leaves that are fully developed.

2.4.3. Fresh Weight of Plants (grams)

The fresh weight of plants is a measurement of plant biomass. The fresh weight of plants is calculated by weighing the plants after the content in the plant has decreased. The greater the height of the plant, the number of leaves and roots, the fresh weight of the plant will increase. Measurements are carried out after post-harvest.

2.4.4. Dry Root Weight

Pagoda mustard greens that have been harvested, then the roots are cut, then cleaned to remove any soil stuck to them, then baked in the oven for 24 hours at a temperature of 150°C.

2.5. Data Analysis Techniques

This study used a factorial randomized block design (RAK) and Duncan's Multiple Range Test (DMRT) analysis. Data analysis used SPSS 24 software.

2.6. Implementation of research

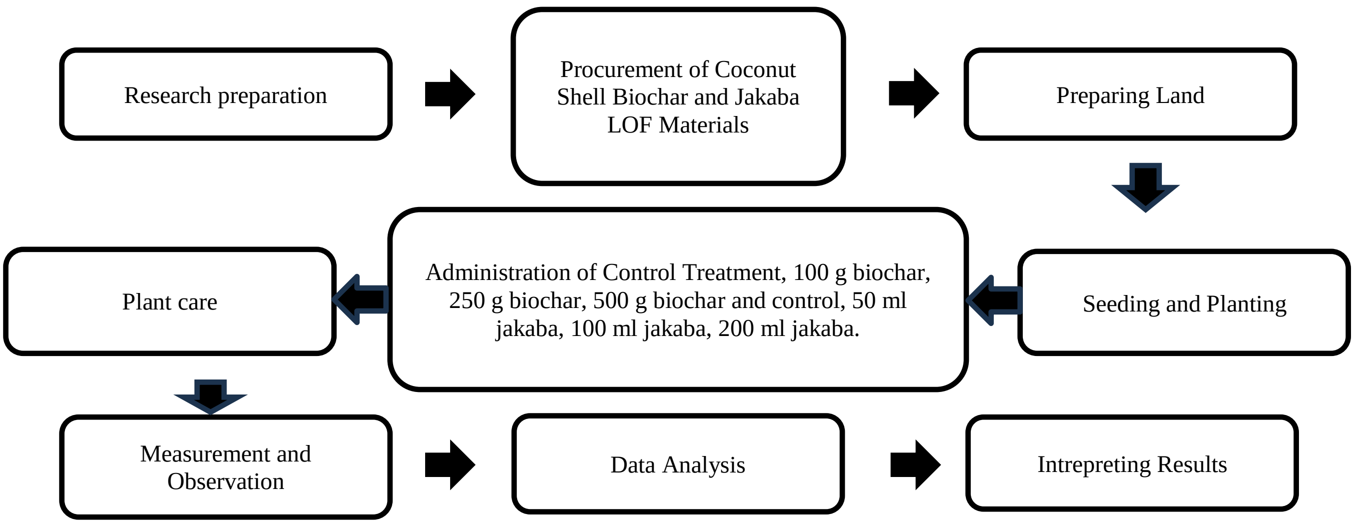

Figure 1. Research Flow Diagram

3. Results and Discussion

3.1. Plant height (cm)

Based on observations of plant height in the field and data analysis using ANOVA, the results are shown in Table 1.

Table 1. DMRT test results for plant height (cm)

Treatment	Mean
control	1.75 ±0.10 a
50 ml Jakaba and 100 g biochar	3.87 ±0.22 b
200 ml Jakaba and 250 g biochar	5.50 ±0.31 c
100 ml Jakaba and 25 0 g biochar	5.25 ±0.30 c
200 ml Jakaba and 100 g biochar	3.25 ±0.18 b
control and 5 00 g biochar	5.25 ±0.30 c
50 ml Jakaba and 5 00 g biochar	6.37 ±0.36 s
50 ml Jakaba and biochar control	3.25 ±0.18 b
10.0 ml Jakaba and 25.0 g biochar	4.62 ±0.26 c
200 ml Jakaba and 250 g biochar	6.50 ±0.37 s
100 ml Jakaba and biochar control	3.25 ±0.18 b
control and 100 g biochar	3.87 ±0.22 b
50 ml Jakaba and 5 00 g biochar	8.00 ±0.46 s
100 ml Jakaba and biochar control	3.25 ±0.18 b
control and 100 g biochar	3.87 ±0.22 b
200 ml Jakaba and 5 00 g biochar	9.25 ±0.53 d

Further test results showed a significant difference in the average height of pagoda mustard plants in various treatments of coconut shell biochar and Jakaba. The treatment of 200 ml Jakaba and 5 00 g biochar had the highest average (9.2500) and was included in the notation group d, showing the best results compared to other treatments. In contrast, the control treatment had the lowest average (1.7500) with the notation a, indicating the lowest growth. Treatments with different notations showed significant differences, while treatments with the same notation were not significantly different. Overall, certain treatment combinations, especially those containing higher doses, tended to increase plant growth significantly. This study is in line with a study by (Ananda et al ., 2023) which found that giving coconut shell biochar at a dose of 200 g/10 kg of soil gave the best results on the growth and yield of pak choy mustard plants. In the study, there was no interaction between rice husk biochar and kirinyuh liquid organic fertilizer on all pak choi growth parameters. The administration of kirinyuh liquid organic fertilizer did not provide the best results on all observation parameters.

3.2. Number of leaves

Based on observations of the number of leaves in the field and data analysis using ANOVA, the results are shown in Table 2.

Table 2. DMRT test results for the number of pagoda mustard leaves (Shells)

Treatment	Mean
control	15.00±0.86a
50 ml Jakaba and 100 g biochar	15.50±0.89a
200 ml Jakaba and 250 g biochar	15.50±0.89a
100 ml Jakaba and 25 0 g biochar	16.50±0.95a
200 ml Jakaba and 100 g biochar	17.00±0.98a
control and 5 00 g biochar	17.50±1.01a
50 ml Jakaba and 5 00 g biochar	17.50±1.01a
50 ml Jakaba and biochar control	18.00±1.03a
100 ml Jakaba and 25 0 g biochar	21.25±1.22a
200 ml Jakaba and 250 g biochar	22.50±1.29a
100 ml Jakaba and biochar control	24.00±1.38a
control and 100 g biochar	24.00±1.38a
50 ml Jakaba and 5 00 g biochar	24.25±1.40a
100 ml Jakaba and biochar control	26.00±1.50a
control and 100 g biochar	28.50±1.64a
200 ml Jakaba and 5 00 g biochar	29.50±1.70a

The results showed that the combination of Jakaba liquid organic fertilizer (LOF) and biochar affected the growth of pagoda mustard plants. Treatment with 200 ml Jakaba and 500 g biochar produced the highest average plant height of 29.50 ± 1.70 cm, followed by control treatment with 100 g biochar and 100 ml Jakaba, with biochar control reaching 28.50 ± 1.64 cm and 26.00 ± 1.50 cm, respectively. Meanwhile, the control treatment without adding Jakaba and biochar showed the lowest growth with an average plant height of 15.00 ± 0.86 cm. This indicates that the combination of Jakaba and biochar can increase the growth of pagoda mustard plants compared to the control. This study is in line with the study by (Suharyatun et al ., 2021), which found that combining rice husk biochar and microbial-based organic fertilizer can increase the growth and yield of vegetables, including mustard greens.

3.3. Fresh Weight of Plants

Based on observations of fresh plant weight in the field and data analysis using ANOVA, the results are shown in Figure 2.

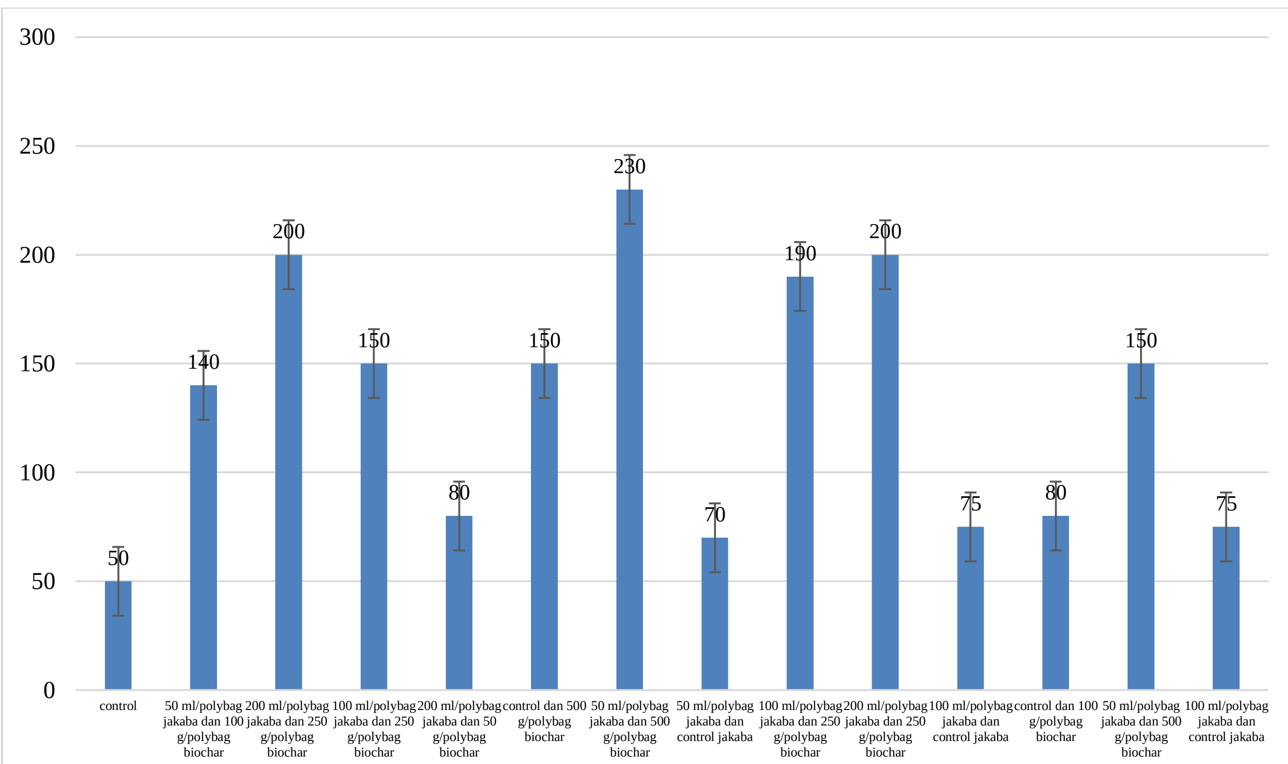

Figure 2. Fresh weight of pagoda mustard plants (grams)

The results of measuring the fresh weight of pagoda mustard showed variations between treatments. The treatment of 200 ml Jakaba and 500 g biochar produced the highest fresh weight, which was 350 grams, indicating that the combination of coconut shell biochar and Jakaba at a certain dose had an optimal effect on the harvest. In contrast, the control treatment produced the lowest fresh weight, which was 50 grams, indicating that without additional treatment, the growth of pagoda mustard was less than optimal. This difference in weight indicates that certain treatments contributed to a significant increase in pagoda mustard production. Research (Muhamat Ikhsan, Anis Rosyidah, 2013) found that the combination of goat manure organic fertilizer and liquid organic fertilizer (LOF) significantly affected the growth and production of pagoda mustard. Although the types of organic fertilizers were different, the results were consistent, and the use of a combination of organic fertilizers could increase the yield of pagoda mustard. Research (Akbar et al ., 2025) showed that providing banana stems LOF with a concentration of 80 ml/liter of water gave the best response with an economic weight of pagoda mustard of 10.195 grams per plant. This result is much lower than the 350-gram weight you obtained, showing the difference in effectiveness between banana stem LOF and the combination of Jakaba and biochar.

3.4. Dry root weight

Based on observations of fresh plant weight in the field and data analysis using ANOVA, the results are shown in Figure 3.

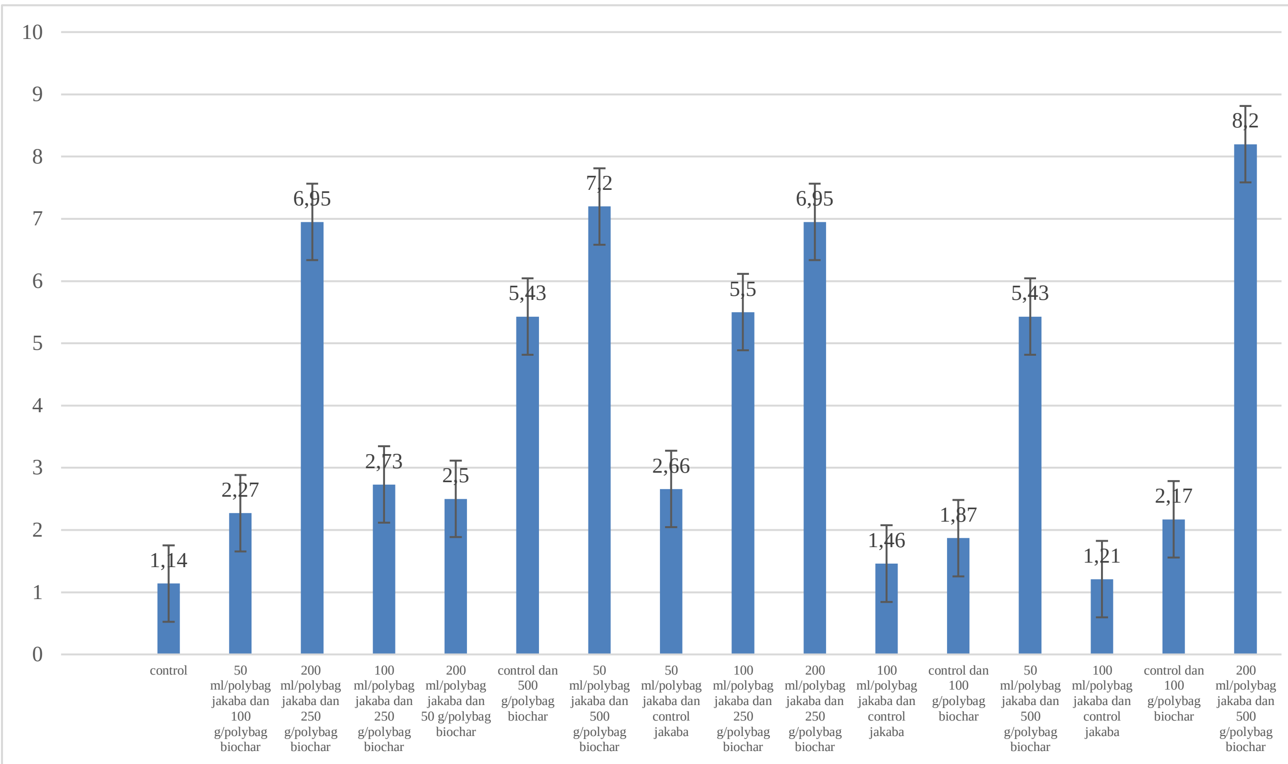

Figure 3. Dry root weight of pagoda mustard plant (grams)

The results of the measurement of the dry root weight of pagoda mustard showed significant variations between treatments. The highest value was obtained in treating 200 ml Jakaba and 5 00 g biochar with a dry root weight of 8.2 grams, indicating that combining coconut shell biochar and Jakaba at a certain dose can increase plant root development. Conversely, the lowest value was found in the control treatment, which was 1.14 grams, indicating that root growth was less than optimal without additional treatment. This difference in weight indicates that the administration of coconut shell biochar and Jakaba can potentially increase the plant root system, which plays a role in the absorption of nutrients and water more efficiently. A similar study by (Suharyatun et al ., 2021) found that combining rice husk biochar and microbial-based organic fertilizer increased vegetable growth and production, including root growth parameters. A different study (Nurbaiti, 2023) showed that the provision of liquid organic fertilizer has not significantly increased soybean plants' growth and yield. However, providing rice husk biochar gave the best results in several growth parameters.

Figure 4. Research documentations

4. Conclusion

Based on the study's results, it can be concluded that the application of coconut shell biochar and Jakaba significantly affects plant height, fresh weight, and dry root weight of pagoda mustard greens. The treatment involving 200 ml of Jakaba and 500 g of biochar yielded the most favorable results. In contrast, the number of leaves did not significantly differ among the treatments, likely due to other influencing factors such as environmental conditions and plant genetics. Using biochar and Jakaba can enhance plant growth and development by improving nutrient availability, soil aeration, and the activity of microorganisms that facilitate nutrient absorption.

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