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RESEARCH ARTICLE — Open Access

Increasing the Growth and Production of Chili Plants (*Capsicum annum* var longum) by administering various Concentrations and Doses of JAKABA Biofertilizer

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Abstract

Chile is a commodity characterized by volatile prices and is a significant contributor to inflation in the Indonesian economy. The agricultural sector faces several challenges, including technical cultivation issues, pest and disease infestations, and low productivity. An innovative fertilization approach utilizing Jakaba biofertilizer, derived from fermented organic matter rich in nutrients and microbes, was explored to address these challenges. This research aimed to evaluate the effectiveness of Jakaba in cultivating chili plants. This research used a factorial method with a completely randomized design (CRD). The first factor was the dosage of Jakaba fertilizer, which consisted of three levels: 100 ml, 200 ml, and 300 ml. The second factor was the fertilizer concentration, with 20 ml/L, 50 ml/L, 90 ml/L, and 140 ml/L. The results indicated that the application of Jakaba biofertilizer, in terms of both concentration and dosage, had a similar effect on all growth parameters of chili plants. The microbiological analysis involved isolating microbes from the biological fertilizer yielded 10 microbial isolates, comprising 4 fungal isolates and 6 bacterial isolates. The study revealed a carbon-to-nitrogen (C/N) ratio 6.598, indicating that the fertilizer had undergone decomposition and contained low nutrient content. Nutrient analysis showed an organic carbon content of 0.239%, total nitrogen of 0.0365%, a C/N ratio of 6.598, a P2O5 value of 0.02125%, and a total potassium (K) value of 0.0205%.

Keywords: Bacteria, Chili Plant, Fungal, JAKABA Biofertilizer, Nutrients

1. Introduction

Chili (Capsicum spp.) is a horticultural commodity with high economic value and increasing demand in domestic and international markets (Sari et al., 2021). Chili plants are essential food ingredients and have a significant role in culinary culture in various countries (Guntzer et al., 2012). However, chili production often faces challenges like pest and disease attacks and suboptimal environmental conditions (Hossain & Khatun, 2018). Excessive use of chemical fertilizers will damage and reduce soil fertility chemically, physically and biologically. Therefore, efforts to increase chili productivity through good cultivation practices and appropriate agricultural inputs are needed (Rizwan et al., 2016).

One innovative approach to fertilization that supports plant growth is biofertilizers, such as Jakaba (Khatun et al., 2017). Jakaba biofertilizer is derived from fermented organic materials rich in nutrients and beneficial microorganisms (Ali et al., 2019). This type of fertilizer supplies essential nutrients for plants and enhances soil health and microbial activity, thereby contributing to increased soil fertility (Kaur et al., 2020). Applying biofertilizers containing beneficial microorganisms can significantly improve soil health (Zahra et al., 2025). Jakaba, in particular, is anticipated to serve as an environmentally friendly and sustainable alternative for enhancing plant productivity (Sari et al., 2021).

This study explores the opportunities for increasing the growth and yield of chili peppers by adding Jakaba biofertilizer compared to NPK fertilizer (Zhang et al., 2018). Applying Jakaba fertilizer is expected to increase the availability of nutrients, improve soil structure, and increase plant resistance to environmental stress, as well as provide better results than conventional NPK fertilizer

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(Rahman et al., 2019). Through this study, it is expected to provide useful information for farmers and agricultural practitioners in optimizing chili cultivation and contribute to sustainable agriculture development in Indonesia (Liu et al., 2020).

2. Material and Methods

The study used a factorial method with a completely randomized design (CRD). The first factor was the dose of biofertilizer with 3 levels: 100 ml, 200 ml, and 300 ml. The second factor was the concentration of biofertilizer with 4 levels: 20 ml/L of water, 50 ml/L of water, 90 ml/L of water, and 140 ml/L of water. The two factors obtained 12 treatment combinations, and each was repeated 4 times. So the number of seeds needed is 3 x 4 x 4 = 48.

The research was conducted from September to January 2025 in Sembego Village, Maguwoharjo, Depok District, Sleman Regency, Special Region of Yogyakarta with coordinates (-7.761576711334259, 110.43831441070205) at an altitude of ±118 m above sea level. In the Sleman area, air humidity reaches 74% - 87%, while the air temperature is 26.1 ° C - 27 ° C. Rainfall is relatively high each year, ranging from 2000 - 3500 mm.

The tools used in this study were hoes, 5-liter buckets, stationery, vernier calipers, digital scales, measuring cups, 25 kg buckets, and knapsack sprayers.

The materials used in this study were cayenne pepper seeds, liquid organic fertilizer from goat urine, phonska plus 15-15-15 fertilizer, NPK fertilizer as a positive control, dolomite fertilizer, black silver mulch, bamboo stakes, grip hose, and PE hose.

Jakaba biofertilizer makes 3 liters of the first rice washing water, adding 1 tablespoon of bran. Then, the mixture is poured into a 25-liter bucket. The bucket is covered with cloth and placed in a shady, dark, cool place. The incubation period is 21 days, and mushroom biomass will be produced, which is shaped like roots.

Microbiological analysis. Jakaba biofertilizer was analyzed microbiologically by isolating it on Nutrient Agar (NA) and Potato Dextrose Agar (PDA) growth media using serial dilution techniques up to 107 and the spread plate method. The microbes that grew will be characterized (both bacteria and fungi).

Nutrient content in Jakaba biofertilizer. The analysis is in the form of organic C, total Nitrogen, C/N, P2O5, and total K contained in Jakaba biofertilizer.

Application of Jakaba biofertilizer in chili cultivation. Initial land preparation activities by cultivating the soil, spraying herbicides, and making beds with a length of 12 mx 1.1 m, basic fertilizers in the form of 10 kg of manure, 6 kg of dolomite, and 3 kg of phonska plus 15-15-15 fertilizer. The beds are covered with black silver mulch. Chili seeds of the curly chili type are planted with a spacing of 50x25 cm in 2 rows of beds. Plant maintenance consists of watering, weeding, and controlling pests and diseases. Watering is done in the morning or evening. Weeding is done mechanically with a knapsack sprayer . Pest and disease control is carried out if there are symptoms of being attacked by pests and diseases; control is carried out by spraying insecticides using a knapsack sprayer. Jakaba biofertilizer is applied according to the treatment at the age of the plant 14 days after planting. Harvesting is carried out after the age of the cayenne pepper reaches 90 - 95 days after planting. The next harvest is carried out once a week for 7 harvests.

The parameters observed consisted of plant height, number of leaves, stem diameter, start of flowering, number of primary branches, number of secondary branches, number of fruits per plant, and weight of plant fruit.

The research data were analyzed using SPSS for analysis of variance (ANOVA) at a real range of 5%. If there is a real difference, further testing is needed with Duncan's Multiple Range Test (DMRT).

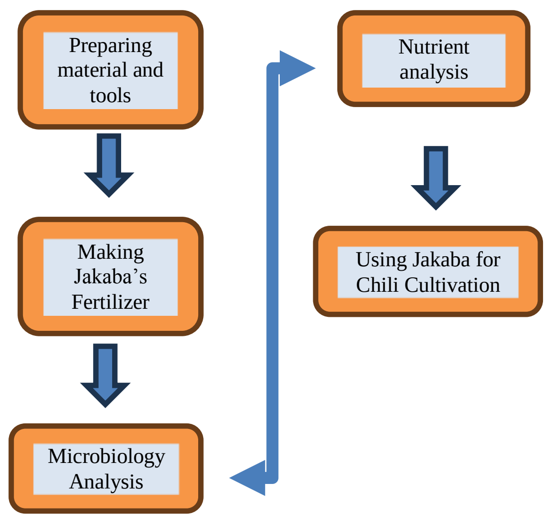

Figure 1. Research Flow Diagram

3. Results and Discussion

3.1. Jakaba Biofertilizer

Jakaba biofertilizer plays a significant role in Indonesian agriculture. The lucky mushroom (jakaba) is derived from the fermentation of rice washing water. Jakaba was discovered accidentally by a farmer named Aba Junaidi Sahidj. Several studies have demonstrated that jakaba contributes to soil fertilization, accelerates plant growth, and helps combat plant diseases such as Fusarium (Azisah, 2021; Norliyani et al., 2023); Ibnusina et al., 2024).

3.2. Jakaba Microbiological Analysis

The results of microbial isolation using serial dilution techniques and the spread plate method successfully revealed that jakaba contains four types of fungi and six types of bacteria that grow on the biofertilizer.

Table 1. Results of microbiological analysis of jakaba

Isolate code	Type	Elevation	Edge	Internal structure
B12	Bacteria	Effusion	Entire	Finely granular
B13	Mold	Convex rugose	Entire	coarse granular
B11	Mold	Effusion	Entire	Opaque
B14	Bacteria	Low Convex	Undulate	Translucent
B21	Mold	Low Convex	Crenate	Filamentous
LP4-22	Mold	Raised with concave beavled edge	Entire	coarse granular
LP4-11	Bacteria	Effusion	Entire	Opaque
LP6	Bacteria	Effusion	Undulate	Opaque
BP5	Bacteria	Effusion	Eros	Translucent
BP4	Bacteria	Convex rugose	Undulate	Opaque

Description: isolate code = jakaba sample analyzed

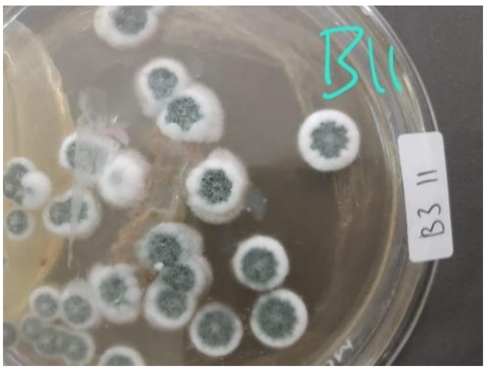

Figure 2. Fungal colony of isolate B11

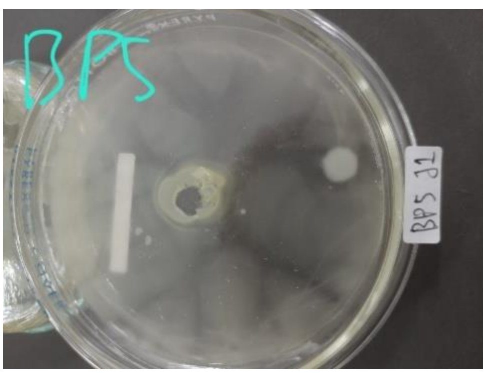

Figure 3. Bacterial colony of isolate BP5

This study revealed that Jakaba does not contain a single type of microbe or fungus but is a consortium of fungi and bacteria that work together to improve soil fertility and increase the growth of chili plants. Research on Jakaba fertilizer as a biological fertilizer contains 6 isolates of bacteria and 4 isolates of fungi suspected of forming a consortium in influencing plant growth and soil fertility. Jakaba biomass, such as roots, can be fungal biomass while other solutions contain bacteria. The characteristics of the isolates are described in table 1. Following the growth of colonies in petri dishes. Each isolate of bacteria or fungi that grows on Jakaba fertilizer has different potentials that we can explore in further research.

3.3. Analysis of nutrient content in jakaba

The analysis was duplicated so that the average values were taken. The results showed that organic C was 0.239%, total nitrogen was 0.0365%, C/N value was 6.598, P2O5 value was 0.02125 %, and total K value was 0.0205%. The organic C content was 0.239%, and the C/N ratio was low at 6.5 (Instiper Central Laboratory, 2025). The low total C content indicates low nutrient content. Low values cause nutrient support for chili plants to be lacking, so Jakaba fertilizer does not affect the growth of chili plants.

Table 2. Nutrient analysis in Jakaba (Instiper Central Laboratory, 2025)

No	Test Parameters	Unit	Sample Code		Test Method
			POC Repeat 1	POC Repeat 2	
1	C Organic	%	0.242	0.236	Walkley&Black
2	Total Nitrogen	%	0.037	0.036	Kjedahl
3	C/N		6,621	6,575	
4	P_2O_5	%	0.0224	0.0201	Ex HNO_3 +$HClO_4$
5	K Total	%	0.0201	0.0209	

The low C/N ratio also inhibits microbial development because carbon and nitrogen are sources of energy for the metabolic activities of the microbial body. Suppose the energy source is not sufficient for the needs of microbes. In that case, their activities in fertilizing the soil or supporting plant growth are not optimal, either in binding free nitrogen, cutting the bonds between macronutrients with Al and Fe, or preventing attacks by plant pathogens (Nopsagiarti et al., 2020).

3.4. Influence Jakaba on curly chili plants.

3.4.1. Vegetative growth of chili plants

The results of the analysis showed that the application of the concentration of biofertilizers had the same effect.

The study showed that the administration of Jakaba fertilizer had the same impact on vegetative growth parameters such as plant height, number of leaves, stem diameter, and number of primary and secondary branches. The essential macronutrient nitrogen influences the vegetative growth of chili plants.

Table 3. Effect of Jakaba concentration on vegetative growth

Parameters	Concentrations			
	20 ml/L water	50 ml/L water	90 ml/L water	140 ml/L water
Plant height	50.82 ± 6.47a	50.67 ± 6.29a	53.05 ± 4.85a	51.53 ± 2.47a
Number of leaves	424.17 ± 165.89a	448.00 ± 249.75a	474.17 ± 187.70a	457.42 ± 123.22a
Stems diameter	6.61 ± 1.08a	6.79 ± 1.08a	7.14 ± 0.93a	6.90 ± 0.55a
Number of primary branches	11.42 ± 1.92a	11.42 ± 1.92a	11.08 ± 1.56a	12.17 ± 1.52a
Number of secondary branches	16.50 ± 5.30a	16.83 ± 3.78a	15.75 ± 4.84a	18.42 ± 2.93a

The nitrogen content in Jakaba biofertilizer, based on laboratory analysis results of 0.0365%, is suspected to be insufficient to support plant height. In addition, soil conditions at the research location also play a role in determining plant growth. Soil pH ranges from 4.5 to 5.5 at the research location, which is one of the causes of the lack of effect of Jakaba administration. Jakaba fertilizer derived from rice washing water and applied to chili plants still cannot boost vegetative plant growth, especially nitrogen elements that affect the development of apical meristems. The analysis showed that the application of biofertilizer doses had the same effect. Soil pH greatly determines the availability of nutrients for plants. Nitrogen in soil with low pH cannot be absorbed directly by plants, so plants lack this element (Patti et al., 2013; Setiyadi, 2020; Sartini, 2021). Plants do not get macronutrients at low pH because macronutrients such as N, P and K are usually bound by microelements such as Fe and Al, so they are not available to plants. Excessive Fe causes plant poisoning with the characteristic of small brown spots on the lower leaves (Zulhadyanto, 2020). The bond must be released in several ways, namely by giving dolomite or biofertilizers to cut the bond. The provision of Jakaba biofertilizer is thought to be unable to cut the bond so that the pH remains low. During the study, the rainfall intensity was also high; even several times, the research location was flooded with water, which is also thought to cause low soil pH.

Table 4. Effect of Jakaba dose on vegetative growth

Parameters	Doses		
	100 ml	200 ml	300 ml
Plant height	51.89 ± 6.03p	51.58 ± 5.63p	5.49 ± 5.47p
Number of leaves	477.85 ± 200.88p	487.75 ± 186.48p	464.50 ± 225.82p
Stems diameter	7.05 ± 0.97p	7.03 ± 1.00p	6.74 ± 1.04p
Number of primary branches	11.70 ± 1.59p	11.55 ±1.53p	11.60 ± 2.16p
Number of secondary branches	17.35 ± 4.20p	17.65 ± 3.13p	16.40 ± 5.06p

3.4.2. Generative growth of chili plants

Table 5. Effect of Jakaba concentration on generative growth

Parameters	Concentrations			
	20 ml/L water	50 ml/L water	90 ml/L water	140 ml/L water
Flowering time	30.33 ± 1.07a	30.58 ± 2.06a	29.83 ± 2.94a	30.92 ± 1.83a
Number of fruits per plant	23.00 ± 20.32a	29.75 ± 19.64a	36.55 ± 21.47a	29.10 ± 20.51a
Weight of fruits per plant	46.82 ± 45.62a	60.92 ± 33.00a	79.09 ± 45.29a	59.40 ± 41.65a

The analysis results show that the concentration of biofertilizer used has the same effect on the generative growth of chili plants. Generative growth was observed starting from flowering time, number of fruits per plant, and weight per plant. The provision of Jakaba biofertilizer did not have a significant effect on the generative growth of chili plants. Several factors that can be learned from the causes of the research results include the content of nutrients that support generative growth, such as P and K. Laboratory results on the content of these nutrients showed that the P element was 0.021% and the total K was 0.0205%. This amount is considered insufficient for the needs of chili plants for generative growth. The P element plays a role in the initiation of flowering. In contrast, the K element regulates plant physiological processes such as photosynthesis, accumulation, translocation, carbohydrate transportation, opening and closing of stomata, or controlling water distribution in plant tissues and cells

(Sahidj, 2020). One of the symptoms of deficiency of these elements is the loss of chili flowers, susceptibility to disease, and the scorching and curling of the edges of the leaves.

Table 6. Effect of Jakaba dose on generative growth

Parameters	Doses		
	100 ml	200 ml	300 ml
Flowering time	30.80 ± 2.56p	30.20 ± 1.57p	30.35 ± 1.89p
Number of fruits per plant	34.44 ± 25.23p	30.84 ± 20.42p	24.56 ± 14.47p
Weight of fruits per plant	73.77 ± 54.46p	66.33 ± 42.98p	51.83 ± 41.65p

The analysis results show that the dosage of biofertilizer has the same effect on the generative growth of chili plants. Jakaba fertilizer, as a biological fertilizer, improves the soil's biological properties by increasing the soil's biological life. In addition, liquid organic fertilizer or microbial fertilizer is a solution containing microbes that are added to the soil, which helps accelerate the growth of roots, shoots, buds, and flowers, providing plant nutrients, improving plant health, and increasing soil fertility (Madusari, 2016).

When administering Jakaba to plants, one must pay attention to the dosage and concentration because administration that does not follow the dosage and concentration can cause plant wilting (Rahmah et al., 2014). The administration of biofertilizer at the dose level has the same effect on the growth and production of chili plants. Chairman Elfin and Efendi (2017) stated that administering fertilizer with a dose that follows plant needs will increase and provide better growth. Regular and routine fertilizer administration will also support plant growth. The results of the study by Ralahalu, Hehanussa, and Oszaer (2013) stated that the administration of biofertilizer with a very high concentration would slow down plant growth and vice versa if the concentration given is very low then plant growth is inhibited, or both do not increase plant growth in both the vegetative and generative phases. A low C/N ratio positively impacts nutrient availability (nitrogen mineralization) because it supports microbial activity. According to Norliyani et al. (2023), the provision of biological fertilizers did not have a significant effect on all observation variables because the analysis showed that podzolic land conditions had an acidic pH, low nitrogen content, organic carbon, and C/N ratio, thus limiting the effectiveness of biological fertilizers in supporting plant growth.

4. Conclusion

Applying Jakaba biofertilizer does not affect the growth and production of chili plants. Jakaba fertilizer contains six bacterial isolates and four fungal isolates in a consortium. The nutrient analysis of Jakaba fertilizer reveals that organic carbon is 0.239%, total nitrogen is 0.0365%, the carbon-to-nitrogen (C/N) ratio is 6.598, phosphorus pentoxide (P2O5) is 0.02125%, and total potassium (K) is 0.0205%.

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