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The Effect of Water and Fertilizer Types on Yield and Protein Content of Supan-Supans (*Neptuniaoleracea*) in Ultisol Soil

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Abstract:
Supan-supan is the local name for water mimosa, an aquatic weed found in South Kalimantan's Lebak swamp. It is consumed by some as an indigenous vegetable. A study on the effect of water and fertilizer types on yield and protein content on Ultisol soil media has been carried out in Banjarbaru from May to June 2021. The experimental design used was a factorial completely randomized design consisting of two treatments. The first treatment was the type of water which consisted of tap water and swamp water. The second treatment was a type of fertilizer consisting of chicken manure, NPK, and water hyacinth bokashi. The doses of the three types of fertilizers were equalized based on the N content. Observations were made on the fresh sellable weight of young shoot, the total weight of fresh plants, the total dry weight of plants, and protein content at the age of 5 WAP. The findings revealed that the type of water and fertilizer had no interaction effect or single effect on the fresh and dry weight of the plants. The single fertilizer treatment affected the total protein content of supan-supan young shoot. Bokashi fertilizer treatment from water hyacinth produced the highest protein content of 6.14%, which was not significantly different from NPK compound fertilizer treatment of 5.99%. According to the findings, supan-supan cultivation could be carried out on water and soil types that are not derived from swamps.

***Key Word**:Indigenous vegetables, legume, nitrogen, water mimosa, wetlands*

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I. Introduction

Supan-supan (*Neptuniaoleracea*) is a wetland weed that grows in several swamps in South Kalimantan. This plant is used as a vegetable by the Banjar people and is classified as an indigenous vegetable. Indigenous vegetables are vegetables that have thrived in a particular region and have been used since their forefathers. Supan-supan contains nutrients that are needed for health maintenance. 100 g of Supan-supan leaves contain 3.23% protein, 1.07% ash content, 0.44% fat, 2.66% fiber, 261.02 KJ energy, 86.26% water content (Saupi, Zakaria, Arshad, & Arshad, 2015).

Supan-supan are sold in several traditional South Kalimantan markets, including the Martapura market. However, the availability of the Supan-supan is only a minor vegetable. Supan-supan that is traded is obtained from swampland that grows wildly, not from cultivation (Susanti, 2015).

Supan-supan grows primarily in swamps near residential areas, cattle pens, and rice fields in Banjar Regency (Susanti & Rusmayadi, 2019).

Supan-supan are not available all year round in the traditional markets of South Kalimantan. Supan-supan is abundant during the rainy season and disappears during the dry season. As a result, people cannot consume these vegetables throughout the year. In addition, if supan-supan is continuously taken from nature, it will quickly experience extinction.Given the enormous benefits of supan-supan for human health, supan-supan needs to be cultivated to be available throughout the year.

This cultivation action is also a step toward wetlands plant conservation. Supan-supan cultivation on non-swamp land should be trialled using soil types from dry land that have been given water as a growth medium. It is intended to facilitate the community in preparing planting media, planting, and harvesting to ensure sustainable production.

Several researchers have cultivated supan-supan in water media, but this only aims to see their phytoremediation ability. Juswardi, Sagala, &Ferdini (2010) and Tanzerina, Juswardi, &Elyza(2013) grew supan-supan in buckets containing various concentrations of liquid ammonia waste to determine plant tolerance in the context of developing phytoremediation. Septiani, Mukarlina, & Wardoyo (2017) cultivated supan-supan with cuttings in a container filled with water and a hydroponic fertilizer solution for 14 days with a natural lighting system in a greenhouse. Aluminum stress treatment was given to observe the growth and anatomical character of Supan-supan in water exposed to aluminum metal. Atabaki et al. (2020) grew supan-supan cuttings hydroponically with various doses of arsenic to prove its ability as a bioremediator in removing arsenic from aquatic systems.

Experiment for increasing supan-supan growth and productivity have not been widely conducted. Sagolshemcha, Thokchom, & Singh (2011) researched the cultivation of supan-supan in pots with soil and water media. The results showed that fertilization with manure at a certain level could increase the growth, plant biomass, and several nodules of *N. prostrata* (synonym with *N. oleraceae*).Saupi, Zakaria, Bujang, & Arshad (2017) conducted research on supan-supan cultivation using a variety of planting materials in order to determine the growth and production of supan-supan. Planting material derived from seeds and cuttings was planted in a container (240 cm x 120 cm x 50 cm) with a mix of soil, sand, and compost (3:2:1; v/v). The supan-supan growing medium was made to imitate its cultivation in flooded rice fields in Thailand, as described by Paisooksantivatana (1993). Sukmana (2021) conducted experiments on supan-supan cultivation in cans filled with ricefield soil and water to determine the effect of various shade levels and chicken manure doses on growth and production.

From these previous studies, there has been no research on the cultivation of supan-supan on various types of water and fertilizer on Ultisol soil to see their effect on biomass production and protein content. Ultisol soil is the dominant soil type on dry land in South Kalimantan. Increased production of biomass and protein content can be carried out simultaneously in cultivation activities. This research is one part of the efforts to conserve medicinal plants from the wetland environment, supporting the "Master Plan of Research at LambungMangkurat University for 2020-2024.

II. Material And Methods

Time and Research Location

The research was conducted in May – July 2021 at the Hydroponic Home of the Agronomy Study Program, Faculty of Agriculture, LambungMangkurat University, Banjarbaru City, South Kalimantan (Figure 1).

Figure1. Research location

Plant Material

Supan-supan stem cuttings measuring 30 cm were used. They were collected from wild plants in the lebak swamp in TanjungRemaDarat Village, Martapura District, South Kalimantan, Indonesia. Stem cuttings had 3 compound leaves at the top (Figure 2).

Figure 2. Stem cuttings used as plant material

Experimental design and treatments

The experiment was arranged using a Factorial Completely Randomized Design consisting of two factors. The first treatment was the water types which consisted of tap water and swamp water. The second treatment was fertilizer types consisting of chicken manure, NPK, and water hyacinth bokashi. The combination of the first and second factors resulted in six combinations repeated three times to obtain 18 experimental units. Each experimental unit consisted of six plant cuttings, so the total plant cuttings in this experiment were 108 pieces.

The tap water contained 0.022 mg/L Ammonia (NH_3), 0.219 mg/L Nitrate (NO_3), 0.400 mg/L Phosphate (PO_4) with a pH of 6.66. Swamp water contains 0.031 mg/L Ammonia (NH_3), 0.299 mg/L Nitrate (NO_3), and 0.263 mg/L Phosphate (PO_4) with a pH of 6.06. The fertilizer dose for each experimental unit was equalized based on the N content, namely 3.75 g of NPK compound (16:16:16), 60 g of chicken manure, and 60 g of water hyacinth bokashi fertilizer.

Implementation

Planting media preparation was carried out by filling styrofoam with 10 kg of Ultisol soil and sand (2:1, v/v). Chicken manure and water hyacinth bokashi fertilizer were mixed with the planting medium one week before planting, while NPK fertilizer was applied at the planting time. Stem cuttings were planted in Styrofoam containers that had been filled with planting media and fertilizer. Planting was performed by adding tap water and swamp water to styrofoam with a water height of 10 cm from the ground. The supan–supan stem cuttings were then inserted to a depth of 3 cm into the soil. Plant maintenance was conducted by maintaining the water level and not taking any plant organs before harvesting. Harvesting was done at the age of 5 weeks after planting (WAP).

Observation

Observations were made on the total fresh weight (g), the total dry weight (g), the fresh weight of the sellable young shoot (g), and the protein content of the whole young shoot (%). The plant's fresh weight was determined using the young shoot and root weights during harvest. The plant's dry weight was determined using the young shoot and root weights dried at 60^0C for 48 hours. The fresh weight of the sellable young shoot was obtained from the weight of the edible young shoot, which had a length of 30 cm taken from each branch. The protein content of sellable young shoot was measured by the Kjeldahl method.

Statistical analysis

The Bartlett test was used to determine the homogeneity of the observed data. If the data are homogeneous, analysis of variance is performed using the F test at 5% and 1% error levels. If the treatment has a statistically significant or very significant effect, the Tukey further test is performed at a 5% error level.

III. Resultand Discussion

Crop Yield

Supan-supan results in the wet weight of sellable young shoot, total wet weight, and total dry weight are presented in Table 1.

Table 1 : Supan-Supan results on the treatment of water and fertilizer types at 5 WAP

Treatment	Wet Weight of Sellable Young Shoot (g)	Total Wet Weight (g)	Total Dry Weight (g)
Water Type			
m1 (Swamp water)	13.01	39.34	10.55
m2 (Tap water)	15.15	41.62	11,24
Fertilizer			
p1 (Chicken manure)	14.30	40.65	11.22
p2 (NPK compound)	16.35	45.74	11.53
p3 (Bokashi water hyacinth)	11.58	35.05	9.94
Interaction	ns	ns	ns

ns = non-significant

Water and fertilizer treatments, either alone or in combination, did not affect the wet weight of sellable young shoot, total wet weight, or total dry weight. Allegedly this is due to the relatively the same N content in the type of water used, while the N content in various types of fertilizers has been equalized. As a result, no increase in supan-supan yields was achieved in both fresh and dry production. Hei et al. (2021) demonstrated that nitrogen fertilizer improved water mimosa's dry weight and yield. The higher the nitrogen content of the fertilizer, the greater the supan-supan total dry weight. Chen, Dong, Yao, & Wang (2018) described the role of nitrogen in increasing crop yields and biomass, stating that applying nitrogen increases the nitrogen content in the leaves, which enables the photosynthetic activity to function properly. The results of photosynthesis are transported to various plant organs leading to increased productivity. Additionally, an increase in nitrogen content correlates positively with plant biomass.

The wet weight of the sellable young shoot produced in the treatment of water types ranges from 13.01 – 15.15 g, while it ranges between 11.58 and 16.35 g in the fertilizer treatment. This value was greater than the wet weight of young shoot harvested at age 5 WAP, ranging between 3.31 and 3.60 g in the Saupi, Zakaria, Bujang, & Arshad (2017) study. Sukmana's study (2021), which used the same dose of chicken manure as this study, also resulted in a lower young shoot wet weight for Supan-Supan plants, namely 11.28 g.

The total wet weight of the plants produced in the water type treatment ranged between 39.34 and 41.62 g, while it ranged between 35.05 and 45.74 g in the fertilizer treatment. The total dry weight of the plants produced in the water treatment ranged from 10.55 – 11.24 g, while in the fertilizer treatment, it ranged from 9.94 – 11.53 g. The wet and dry weights in this study were lower than the study by Sukmana (2021), which used doses of chicken manure with the same nitrogen content of 54.72 and 13.51 g, respectively. However, the total wet and dry weight of plants in Sukmana's study (2021) was obtained from Supan-Supan plants harvested at 6 WAP. If the harvest in this study was carried out at 6 WAP, the plant's total wet and dry weight was likely higher.

Protein Content

The protein content of sellable young shoot in the treatment of water and fertilizer types is presented in Table 2. The type of water treatment did not affect the protein content, while the fertilizer treatment significantly affected the protein content. The protein content in the sellable young shoot treated with several types of water ranged from 5.86 to 6.04%. The water hyacinth bokashi fertilizer treatment had the highest protein content (6.14%). This value, however, did not differ significantly from the treatment content of NPK compound fertilizer (5.99%). The lowest protein content (5.73%) of sellable young shoot was found in chicken manure treatment.

Table 2 : The protein content of Supan-Supan sellable young shoot treated with various types of water and fertilizer

Treatment	Protein Content (%)
Water Type	
m1 (Swamp water)	5.86
m2 (Tap water)	6.04
Fertilizer	

p1 (Chicken manure)	5.73^{b}
p2 (NPK compound)	5.99^{ab}
p3 (Bokashi water hyacinth)	6.14^{a}
Interaction	Ns

Means with the same letter superscript within columns are not statistically different using Tukey's at P > 0.05 probability level. ns = non-significant

Protein is a naturally occurring organic compound found in all living organisms. Protein is consisted of amino acids (Joshi, 2018). N is a fundamental element in the formation of amino acids. In this study, various fertilizers with the similar nitrogen content had varying effects on the protein content of sellable young shoot of supan-supan plants. It is consistent with Iren, Udo, Asawalam, &Osodeke (2016), which showed that applying various types of organic fertilizers and urea with the same N content resulted in a variation in the protein content of *Amaranthuscruentus*. Based on this fact, it can be assumed that the N content in fertilizer is not the primary determinant in protein formation. According to Wang, Li, &Malhi(2008), the concentration of plant protein is highly dependent on the availability of N in plants. The N supply in plants is determined by the amount of N available in the soil at planting time. The N is released during the growing season through mineralization of soil organic matter and the fertilizer used as a source of N nutrients.

Water hyacinth bokashi treatment produced the highest protein content but was not significantly different from the NPK compound. The chicken manure treatment produced the lowest protein content. It is suspected that water hyacinth bokashi and NPK compounds are more quickly absorbed by plant roots and available for protein synthesis. NPK compounds in the form of inorganic fertilizers have been designed as a quickly available fertilizer to plants. Rahmawati (2020) supports this assertion by stating that when organic water hyacinth fertilizer in the form of bokashi is applied, the nutrients decompose rapidly and are readily available to plants compared to chicken manure. Bokashi is a fermented organic product. Because the chicken manure is not in the form of bokashi, its availability to plants is delayed.

The protein content of sellable young shoot in this study was around 5.73 – 6.14%, almost close to the protein content in the Paisooksantivatana study (1994), which was 6.4%. This value is lower than the protein content in the sellable young shoot of wild supan-supan plants found in several Banjar Regency swamps, ranging from 7.88 to 9.81% (Mubarok 2018). However, this protein content is higher than the study results by Saupi, Zakaria, Arshad, & Arshad (2015), which only ranged from 3.01 to 3.23%.

IV. Conclusion

The interaction between the types of water and fertilizer used in Ultisol soil media did not affect supan-supan plants' yield and protein content. Water hyacinth bokashi fertilizer treatment produced the highest protein content of 6.14%. It was not significantly different from the treatment with NPK compound fertilizer. Therefore supan-supan cultivation could be carried out on soil and water media that do not come from swamps. Further research is needed to determine the optimal fertilizer dose and timing for maximum results.

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