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Enhancing sweetness: The impact of biofertilisers on purple sweet potato cultivation in mineral soil

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Abstract

Purple sweet potatoes (*Ipomoea batatas*) have captured the attention of nutritionists and food enthusiasts alike for their rich anthocyanin content, contributing to their vibrant hue and potential health benefits. However, purple sweet potato is not as popular as the orange and white varieties because of the high anthocyanin content, which may cause the purple sweet potato to taste less sweet than the other varieties. The purple sweet potato, known as Lembayung, has a high anthocyanin content (3.19-7.05 mg/100g) and tastes less sweet than other commercial varieties. Enhancing its' sweetness will make it even more acceptable to the consumer while being a healthy starch substitute. Biofertilizer is a low cost and renewable source of plant nutrients that supplements chemical fertiliser. They have a symbiosis relationship with plant roots, where they break down nutrients in the soil for easy absorption and change of sugar from plant roots. This study was carried out to determine the effects of biofertiliser with chemical fertiliser application on quality (sweetness) and yield of Lembayung planted in mineral soil. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatment involving combination of biofertiliser with chemical fertiliser and application of processed chicken dung as a basal fertiliser resulted in the highest sweetness with total sugar and SSC (Soluble solid content) of sweet potatoes. Studies conducted in MARDI reveal that biofertiliser application on the 2nd and 4th week after planting combined with chemical fertiliser application on the 3rd, 5th and 8th week after planting can improve the sweetness and yield of Lembayung sweet potatoes planted in mineral soil. This was demonstrated by increased total sugar in Lembayung tubers by up to 123.8% compared to sweet potato plants fertilised only with chemical fertilisers.

Keywords: Biofertiliser; Sweet Potato; Sweetness; Yield; Chemical Fertilizer; Purple Sweet Potato

1 Introduction

Sweet potato (*Ipomoea batatas* L.) is an important staple food crop in several countries, including Asia and the Pacific Islands. In Malaysia, sweet potato is the second most crucial root crop after cassava. Planting sweet potato is challenging since most agricultural lands are now converted for industrial use. Apart from that, high input costs such as fertiliser, marketing issues, pest and disease outbreaks also make planting this crop difficult. [1, 2]. Purple sweet potatoes (*Ipomoea batatas*) have captured the attention of nutritionists and food enthusiasts alike for their rich anthocyanin content, which contributes to their vibrant hue and potential health benefits. It is also an important staple food crop in

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several countries, including the Asia and Pacific Islands regions. However, purple sweet potato is not as popular as the orange and white varieties because of the high anthocyanin content, which may cause the purple sweet potato to taste less sweet than the other varieties. Achieving optimal sweetness in these tubers can be a delicate balance influenced by various factors, including soil health, nutrient availability, and microbial communities. Purple sweet potatoes are just like any other sweet potato variety that can be consumed freshly. However, they taste less sweet due to having phytonutrients (anthocyanins), which contributes to bitter, acrid or astringent taste. Lembayung purple sweet potato was launched by MARDI in 2021. It is crowned as a sweet potato with high anthocyanin content and can be consumed fresh. Anthocyanins are a group of antioxidants that, if regularly consumed, may prevent inflammation and protect against type 2 diabetes, cancer, and heart disease. Its advantages in the health aspect are expected to increase commercial value and be accepted in the market at a higher price. However, the sweetness of Lembayung is lower than other commercial sweet potato varieties. Lembayung sweet potato has high anthocyanin content (3.19-7.05 mg/100g) and tastes less sweet than other commercial varieties. Enhancing its' sweetness will make it even more acceptable to the consumer while being a healthy starch substitute. Biofertiliser is a substance containing living microorganisms that, when applied to seed, plant surfaces, or soil, colonise the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant. They work by fixing, solubilising and transporting nutrients from the soil into the plants. Biofertilisers include nitrogen fixing, solubilising and mobilising Phosphorus and Potassium, providing micronutrients and promoting plant growth [4]. The sweetness of sweet potatoes can be improved using biofertiliser. Plant roots and microorganisms work in symbiosis where microbes give nutrients to the roots, and roots provide simple sugars to the microbes as "payment" [3]. The utilisation of biofertilisers can contribute to the improvement of soil and environmental factors. Biofertilisers contain beneficial microorganisms, such as bacteria, fungi, and algae, which enhance nutrient availability and nutrient cycling in the soil. Nitrogen-fixing bacteria found in biofertilisers can convert atmospheric nitrogen into a form that plants can use. This improves soil fertility by providing a natural nitrogen source, reducing the need for synthetic fertilisers. Some microorganisms in biofertilisers can solubilise phosphorus, making it more available to plants. This is important because phosphorus is an essential nutrient for plant growth. Biofertilisers can enhance a plant's ability to withstand environmental stress, such as drought or disease and reduced stress levels may allow the plant to allocate more energy to the production of carbohydrates, potentially leading to sweeter sweet potatoes. Some fertilisers contribute to the decomposition of organic matter in the soil. Therefore, this study aims to determine the effects of biofertiliser together with chemical fertiliser application on quality (sweetness) and yield of Lembayung planted in mineral soil.

2 Material and methods

2.1 Study site

The experiment was conducted at the Malaysian Agriculture Research and Development Institute (MARDI), Serdang, Selangor, Malaysia. The soil used in the experiment was mineral soil. The land was prepared by ploughing, followed by rotary tilling of the soil using a tractor. The size of the ridge was 60 cm high and 100 cm wide at the base. Space beds about 1.0 to 1.2 meters apart to allow ample space for vine growth.

2.2 Experimental design

Table 1 Treatment Biofertiliser and chemical fertiliser with basal organic fertiliser.

Treatment	Treatment description
T1	300 kg/ha NPK (13:13:21) (Basal organic fertiliser using chicken dung)
T2	450 kg/ha NPK (13:13:21) + N Biobooster (Basal organic fertiliser using chicken dung)
T3	450 kg/ha NPK (13:13:21) + N Biobooster (Basal organic fertiliser using biorichar)

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments consisted of two basal fertilisers (Biorichar and chicken manure), as shown in Table 1. By comparing the effects of Biorichar and chicken dung as basal fertilisers, the experiment aims to evaluate their effectiveness in enhancing soil fertility and improving crop productivity, especially sweet potatoes. Results from such experiments can provide valuable insights into sustainable agricultural practices and the optimal use of organic fertilisers. The purple sweet potato variety used in this experiment was Lembayung. Prior to planting, the Lembayung shoot cuttings (30 cm long) were soaked with carbaryl solution for 15 minutes. Application of biofertiliser was on the 2nd and 4th week after planting. Chemical fertiliser was applied on the 3rd, 5th, and 8th week after planting. The plot was irrigated regularly using a sprinkler system. The field was routinely irrigated by a sprinkler system. Plants were harvested after three months of planting. Tubers were collected for quality analysis.

The total sugar content was analysed using High-Performance Liquid Chromatography (HPLC) coupled with refractive index (RI) detection [11]. The total anthocyanin concentration was measured using the pH differential spectrophotometry method [10]. All data was statistically analysed by Statistical Analysis System (Version 9.4, SAS Institute Inc, North Carolina, USA). The data obtained was analysed using ANOVA and differences among treatment means were determined using Tukey's Honest Significant Difference (HSD) at $P \leq 0.05$ %.

3 Results and discussion

3.1 Sweet potato yield

The experiment showed that total vines per plant were significantly influenced by combination of chemical and biofertiliser applications (Figure 1- A). The highest total vines per plant were obtained from T3 (450 kg/ha chemical fertiliser with biofertiliser and application of Biorichar as a basal fertiliser (1.56 kg)) while the minimum total of vines was obtained from T1 (300 kg/ha chemical fertiliser without Biofertiliser (1.14 kg)). The maximum weight of tuber produced per plant (0.85 kg) was obtained from T3 (450 kg/ha chemical fertiliser with biofertiliser and application of biorichar as a basal fertiliser) (Figure 1-B) while the minimum weight of tuber (0.52 kg) was obtained from treatment T1 (300 kg/ha without biofertiliser). Biofertilisers help fix nitrogen and solubilise phosphorus, which makes them readily available for plant roots [7]. The result from this study also agrees with the study done by Naglaa [9]. Tuber inoculation with Bacillus sp. significantly affected yield and yield components in both years [8]. The application of biofertiliser in combination with chemical fertiliser was proven to enhance growth and yield of plants compared to the single use of biofertiliser [5].

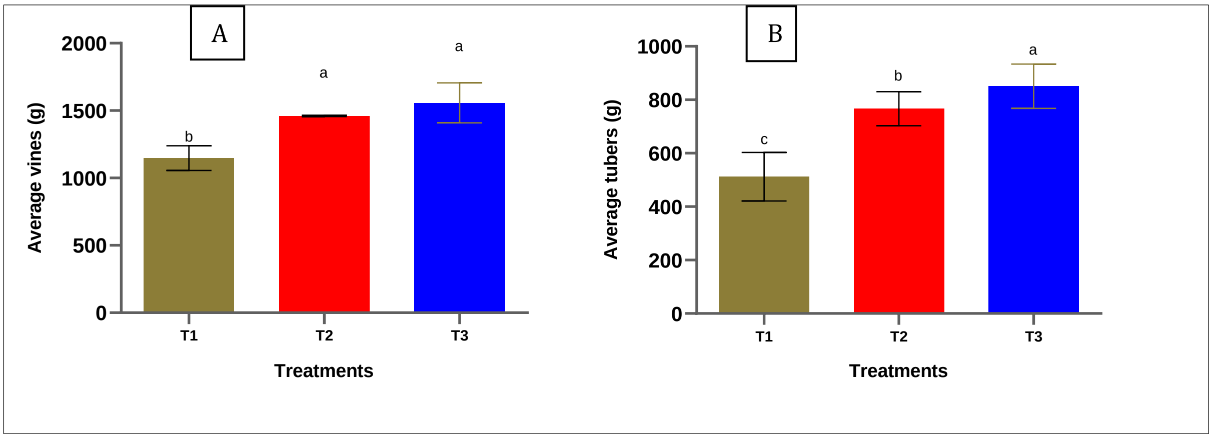

Figure 1 Effects of chemical fertiliser rate and biofertilser on vines (A) and tubers (B) performance of Lembayung. Means in each graph with the different letters indicate significant differences at $P \leq 0.05$% level according to Tukey's HSD.

3.2 Quality (Total sugar, anthocyanin)

Total sugar (fructose, maltose, sucrose and glucose) was increased significantly with biofertilisers. Application of chemical fertiliser with biofertiliser, significantly affected the total sugar of tubers. The total sugars are essential indices for evaluating fruit quality [6]. Results showed that the maximum total sugar was obtained from T2 (450 kg/ha chemical fertiliser with biofertiliser and application of Biorichar as a basal fertiliser 13.9g/100g however, the minimum total sugar was obtained from T1 (300 kg/ha without biofertiliser) 6.21g/100g. Similar studies on strawberries [4], resulting in the increase of soluble sugars in the fruit. This reveals that biofertilisers influence not only the plant yield, but also the quality of fruits. The sweetness of sweet potatoes primarily comes from their natural sugars, such as sucrose, glucose, and fructose, which are present in varying amounts depending on the type and maturity of the sweet potatoes. Results showed that the maximum total anthocyanin was obtained from T1 (300 kg/ha without biofertiliser) 290.9 mg/L compared to T2 (450 kg/ha chemical fertiliser with biofertiliser and application of chicken dung as a basal fertiliser) 266.0 mg/L and T3 (450 kg/ha chemical fertiliser with biofertiliser and application of biorichar as a basal fertiliser) 256.1 mg/L (Figure 3). These results indicate that anthocyanin levels were not compromised with the application of chicken dung compared to control. A similar finding was also reported [12].

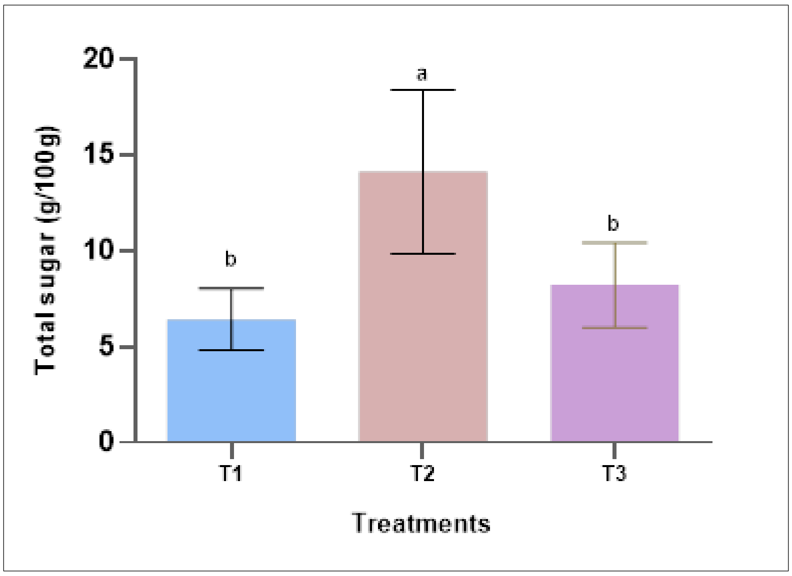

Figure 2 Effects of biofertiliser application on total sugar of Lembayung sweet potato. Means in each graph with the different letters indicate significant differences at P≤0.05% level according to Tukey's HSD.

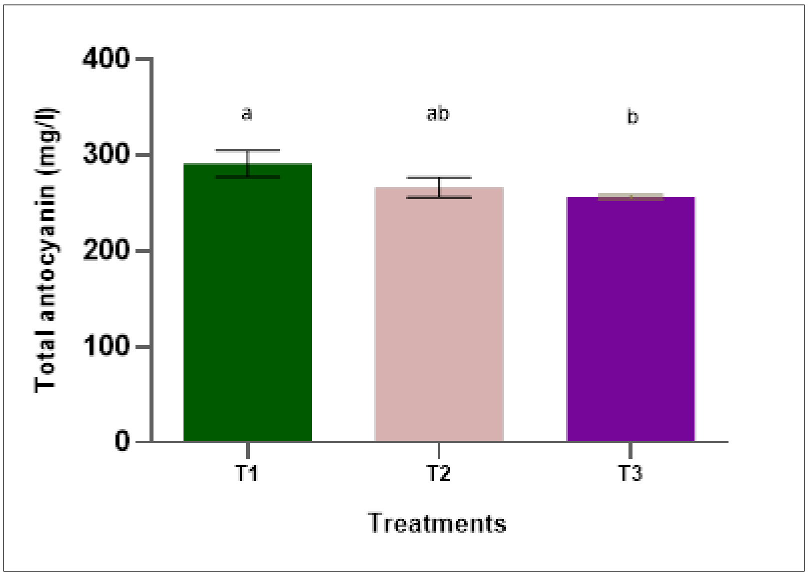

Figure 3 Effects of biofertiliser application on total anthocyanin (mg/l) of Lembayung sweet potato. Means in each graph with the different letters indicate significant differences at P≤0.05% level according to Tukey's HSD.

4 Conclusion

The study recommends using 450 kg/ha of chemical fertiliser combined with Biofertiliser (N Biobooster) and chicken dung as a basal fertiliser to enhance the sweetness of Lembayung sweet potato grown in mineral soil. Although the combination of 450 kg/ha of chemical fertiliser, Biofertiliser (N Biobooster), and biorichar as a basal fertilizer generally increased yield, it did not improve the sugar content of the tubers. This fertilisation method can be applied to other tuber crops grown under field conditions. The use of fertiliser without chemical fertiliser is not recommended, as it results in lower yield and poor-quality tubers in mineral soil.

Compliance with ethical standards

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Disclosure of conflict of interest.

No conflict of interest to be disclosed.

References

[1] Tan SL, Abdul Aziz AM and Zaharah A. Selection of sweet potato clones with high starch content in Malaysia. Concise papers of the second international symposium on sweet potato and cassava. 2005, 77-78.

[2] Loebenstein G. The Sweet Potato: Origin distribution and economic importance. In: Loebenstein G, et al. editors. Springer; 2009, 9–12.

[3] Nils Hennion et al. Sugars en route to the roots. Transport, metabolism, and storage within plant roots and towards microorganisms of the rhizosphere. Physiologia Plantarum 2018, ISSN 0031-9317.

[4] Shaista Nosheen, Iqra Ajmal, and Yuanda Song. Microbes as Biofertilisers, a Potential Approach for Sustainable Crop Production. Sustainability 2021, 13, 1868. https://doi.org/10.3390/ su13041868.

[5] Mekki, B E. Effect of bio-organic, chemical fertilisers and their combination on growth, yield and some macro and micronutrients contents of faba bean (*Vicia faba* L). Bioscience research, 2016, 13(1):8-14.

[6] Wenkai Duan, Lingyao Peng, Hui Zhang, Lu han, Yongquan Li. Microbial biofertilisers increase fruit aroma content of Fragaria x ananassa by improving photosynthetic efficiency. Alexandria Engenering Journal, 2021, 60, 5323-5330.

[7] Singh A. and Singh J N. Effect of biofertilisers and bioregulators on growth, yield, and nutrient status of strawberry cv. Sweet Charlie. Indian Journal of Horticulture 2009, 66(2): 220-224

[8] Ekin, Z., F. Oğuz1, M. Erman and E. Öğün. The effect of *Bacillus* sp. OSU-142 inoculation at various levels of nitrogen fertilization on growth, tuber distribution and yield of potato (Solanumtuberosum L.) African Journal of Biotechnology. 2009. 8 (18): 4418-4424.

[9] Naglaa, H. Hussien, Azza A. Ghazi. Effect of bio and mineral fertilization on sweet potato productivity and quality. Preceeding of 1st International Conference of Applied Microbiology (March 1-3 (2016). pp 21-35.

[10] Koraqi, H., Petkoska, A. T., Khalid, W., Sehrish, A., Ambreen, S., & Lorenzo, J. M. Optimization Of The Extraction Conditions Of Antioxidant Phenolic Compounds From Strawberry Fruits (Fragaria X Ananassa Duch.) Using Response Surface Methodology. *Food Analytical Methods*, 2023, 1–13.

[11] Bench manual D23A/M22. Determination of sugar profile (HPLC method). 2022. Issue 4 (Rev.0). MARDILab, Serdang Selangor.

[12] RV Dhopavkar., Priyanka Malvade NB Gokhale., UB Pethe., VD Kapse., KP Vaidya., MC Kasture and SS More. Effect of fertilizers, biofertilizers and micronutrients on yield and quality of brinjal (Solanum melongena L.) in Alfisol of konkan. The Pharma Innovation Journal 2019:8(12):423-426.