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PADDY HUSK BIOCHAR TO IMPROVE GROWTH QUALITY OF ENGLISH LAVENDER (*Lavandula angustifolia*) IN THE LOWLANDS OF TERENGGANU, MALAYSIA

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Abstract: English lavender (*Lavandula angustifolia*) is a multi-use ornamental plant native to the Mediterranean. In Malaysia, lavender has also been cultivated in the lowlands as a potted plant, besides Cameron Highland. However, studies on lavender cultivation are very scarce in Malaysia. Hence, this study on the effect of biochar on the growth quality of lavender cultivated as a potted plant in the lowland was initiated. This study was conducted in a greenhouse at Batu Rakit, Kuala Nerus, Terengganu, for seven weeks after transplanting. Growing media consisted of 3:7 soil:sand without biochar as the control. About 50g of paddy husk biochar and coconut shell biochar were added to the growing media as treatments, respectively. The parameters observed were plant height, stem diameter, number of branches, fresh and dry weight of shoots and roots and roots-to-shoots ratio biomass. This study found that adding biochar to the growing media positively affected the growth quality of the plants compared to the control. Paddy husk biochar significantly ($P<0.05$) improved stem height, number of branches and the root dry weight of *L. angustifolia*. Hence, adding paddy husk biochar in growing media is worth considering for English lavender cultivation in the lowlands of Malaysia.

Keywords: Agricultural waste, Batu Rakit, coconut shell, *Lavandula angustifolia*, paddy husk.

Introduction

Floriculture is a specialized branch of horticulture that deals with the commercial production of cut and loose flowers, cut greens, seeds, bulbs, and landscape plants. According to the Deputy Minister of Agriculture and Food Industry, Malaysian national flower production was estimated at 414 million cuttings or vases worth RM270 million (Bernama, 2022). The industry is estimated to grow by 6.2% per year, so exploring and developing high-value products is encouraged (Bernama, 2022).

Lavandula angustifolia is native to the Mediterranean and known as true lavender. It is an attractive plant with purple flowers and a soothing fragrance. Lavender is a versatile plant with many uses, including as potted ornamentals and for landscaping. It is also used in perfumery, cosmetics and pharmaceuticals (Pistelli *et al*., 2017). It is also edible and used as a natural preservative (Wells *et al*., 2018) and flavouring (Carla Da Porto *et al*., 2009).

In Malaysia, *L. angustifolia* is successfully cultivated in Cameron Highland as potted and bedding plants for the landscape. Potted lavender can be purchased from Agro Technology Park MARDI and Cameron Lavender Garden. Cameron Highlands sits at an altitude between 300 m and 2060 m above sea level and its total area is approximately 69,699 km^2. In 2019, the minimum temperature in Cameron Highlands was 12°C and the maximum temperature was 34°C (How Jin Aik, *et al*., 2020). Besides Cameron Highlands, *L. angustifolia* is also cultivated in the lowlands of Malaysia in plant nurseries but is limited to potted plants for ornamental purposes. However, research on lavender cultivation in Malaysia is scarce compared to research on lavender essential oil application and active compounds, although interest in it as an ornamental plant is increasing.

Biochar, also called agrichar, is a charcoal derived from the thermal decomposition of a wide range of carbon-rich biomass materials, such as grasses, hard and soft woods, and agricultural and forestry residues (Yao *et al*., 2012). Biochar is a porous, carbon-rich material produced by heating organic matter to temperatures of between 300°C and 1000°C in an environment with limited or no oxygen (Verheijen *et al*., 2010). Many positive effects of biochar treatment on growing media on plant growth have been reported. Recently, Guo *et al*. (2023) found that planting media treated with peanut biochar at 5% improved total N, P, and K, reduced pH, and increased the water retention capacity of the shrub growth using recycled concrete aggregate substrates. Lehmann *et al*. (2011) explained that biochar physicochemical properties can cause changes in the soil nutrient and carbon availability and provide physical protection to microorganisms against predators and desiccation, which may alter the microbial diversity and taxonomy of the soil. Hence, this study was conducted to investigate the effectiveness of biochar on the growth quality of lavender in a lowland environment in Terengganu.

Materials and Methods

Plant Material and Growing Conditions

L. angustifolia were purchased from MARDI, Cameron Highlands, Pahang. The study was conducted between January until March 2020 in a partially covered greenhouse in Batu Rakit, Kuala Nerus, Terengganu (5.4410°N, 103.0282°E). The temperature and relative humidity of the greenhouse were monitored using a data logger (Tinytag TGP-4500 Plus 2, Gemini Data Loggers, UK). The soil, sand, peat moss, perlite, chicken dung, paddy husk, and coconut shells for propagation and growing media preparation were obtained from Universiti Malaysia Terengganu, Bukit Kor, Marang, Terengganu (5°13'0"N 103°9'28"E). The paddy husk and coconut shell biochar were prepared using a conventional pyrolysis process as described by Wan Zaliha and Anwaruddin (2017). The process entailed putting the selected agriculture waste into a modified drum container and heating it to high temperatures (~ 550^{o}C) in an environment with limited or no oxygen for 2-3 days for each biochar type.

The lavender plants were conditioned for two weeks under shade prior to propagation. Propagation by stem cutting was carried out by selecting healthy and fresh stems of the lavender plants, which were then cut to 6 cm lengths from the selected node using sanitized and sharp secateurs. All leaves 2 cm from the cut stem end were removed. The stem was then dipped into a rooting hormone called Indole Butyric Acid (IBA) and planted into propagation media containing a mixture of 55% peat moss, 40% perlite, and 5% chicken dung, as practised in MARDI Cameron Highland (Personal communication, Noor Aini Abu Bakar, December 2019). After four weeks of propagation, the plant roots were fully developed. The plants were then transplanted into the treatment media which contained a mixture of 3:7 soil:sand as the control media (T1), 3:7 sand:soil added with 50 g paddy husk biochar (T2) and 3:7 sand:soil added with 50 g coconut shell biochar. They were planted in 11 cm x 8 cm x 11 cm pots. The plants were manually watered twice a day. The experiment was conducted using a Complete Randomized Block Design (CRBD) with five replications.

Growth Analysis

The plants' height in cm was measured from the soil surface to the top level of the plant using a ruler once a week, starting from the transplanting process until the harvesting day. The stem diameter was measured using a digital Vernier calliper, marked 3 cm from the ground level and recorded in cm. The number of branches was counted manually every week.

Fresh and Dry Weight of Shoots and Roots, and Root-to-Shoot Ratio

During harvest, the aerial parts were separated from the roots. Then, each of the parts was weighed in g and noted as fresh weight (W_0). The parts were then dried at 60°C for three days and then cooled down in a desiccator. The cooled plant parts were then weighed and noted as dry weight (W_1). The root-to-shoot ratio was calculated by dividing the root dry weight by the shoot dry weight (Fascella *et al*., 2020b).

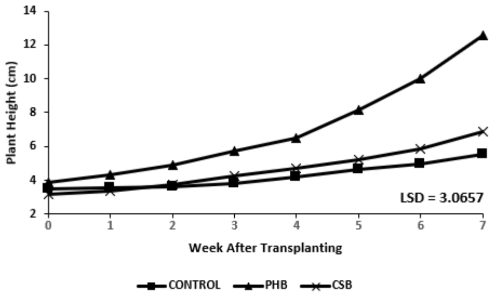
Statistical Analysis

The data were analyzed using one-way ANOVA and the Kruskal-Wallis Test with one factor, which is the different types of biochar treatment, using SPSS Statistics version 26 (IBM Corporation, 2019). Tukey's post hoc test was conducted for the least significant difference between treatments.

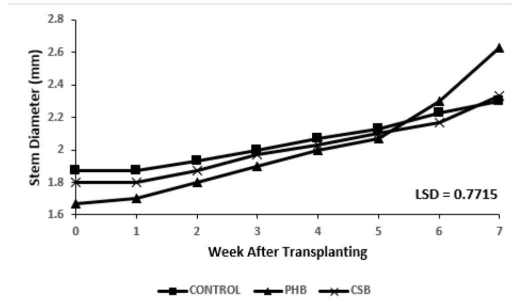
Results and Discussion

Lavandula angustifolia grows naturally in the Mediterranean mountains as high as 1700 m above sea level (JKEDI, 2020), where the climate is characterised by mild, wet winters, and warm to hot and dry summers (Lionello, 2006). It is normally cultivated at an average temperature of 16-18°C (Sierra *et al*., 2009) and takes about seven months to flower from seedlings (Korkunc, 2018). The environment in Batu Rakit, Terengganu, is in total contrast to *L. angustifolia's* origin. Batu Rakit is at the coastline about 6 meters above sea level (Anuar & Abdul Latif, 2017) with hot and humid weather during the hot season and exposure to heavy rain during the Northeast monsoon from November to February (Husain *et al*., 1995). In this study, the average temperature recorded in the greenhouse during the experiment in January, February and March 2020 was 26°C, 26°C and 27°C, respectively. The average relative humidity (RH) was 82%, 81% and 82% in January, February and March 2020, respectively.

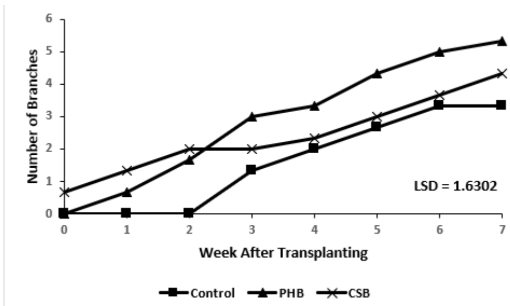
Growing *L. angustifolia* with the addition of biochar for seven weeks showed a significant difference ($p < 0.05$) in the plant stem height [Figure 1(a)]. The initial plant height at transplanting was 3 cm. After seven weeks of transplanting, media containing paddy husk biochar (PHB) produced the highest plant height increment, which was 1.92-fold (9.6 cm), followed by coconut husk biochar (CSB) growing media mixture with a plant height increment of 1.53-fold (7.6 cm). The control growing media, which contained only soil and sand at 70:30 ratio had the lowest plant height increment of 1.25-fold (6.3 cm). Although the stem diameter of plants treated with PHB again showed better results than the other two treatments, the result was not significantly different ($p > 0.05$). The diameter increments between the control and all the treatments were slightly different, which was only 0.12-fold on average [Figure 1 (b)]. *L. angustifolia* grown in media treated with biochar significantly ($p < 0.05$) increased the branch production of the plant [Figure 1(c)]. Plants in growing media containing PHB and CSB were more vigorous as they produced on average five and four branches, respectively, compared to the control, which produced only three branches on average after seven weeks of transplanting (Figures 2).



(a)

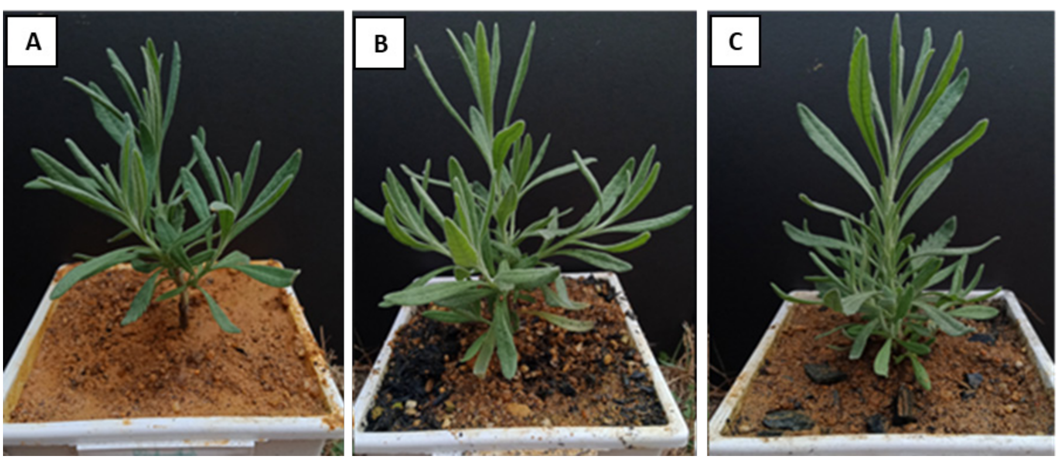


(b)



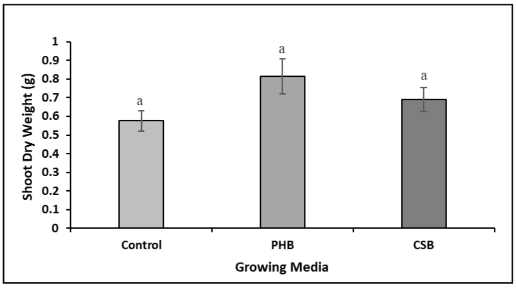
(c)

Figures 1: Effect of different biochar treatments on average (a) plant height, (b) stem diameter, and (c) the number of branches of *L. angustifolia.* PHB = paddy husk biochar; CSB = coconut shell biochar

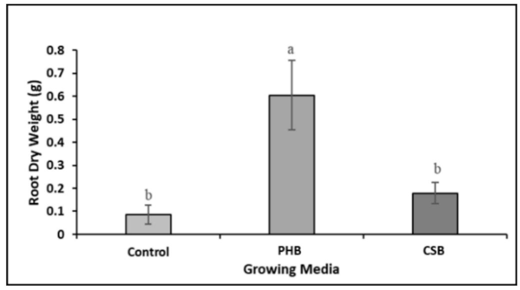


Figures 2: *L. angustifolia* at week six after transplanting into different growing media of (A) Control, (B) PHB, and (C) CSB

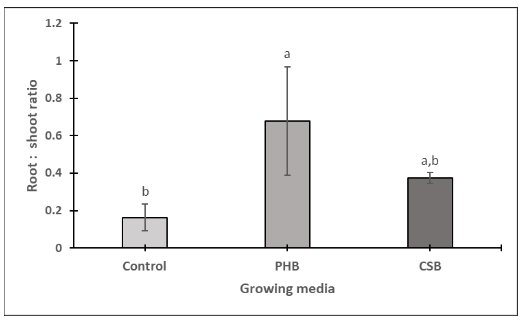
Besides improving height and branch production, PHB also displayed better shoot dry weight, although the attribute was not significantly different ($p < 0.05$) when compared to the control and CSB [Figures 3(a, b, and c)]. Adding PHB to the growing media significantly ($p < 0.05$) improved the root dry weight of *L. angustifolia.* The roots grown in PHB media also looked healthier and more vigorous than the other treatments (Figures 4). Although the root-to-shoot ratio of PHB was greater than control and CSB, the result is insignificant [Figure 3(c)].



(a)

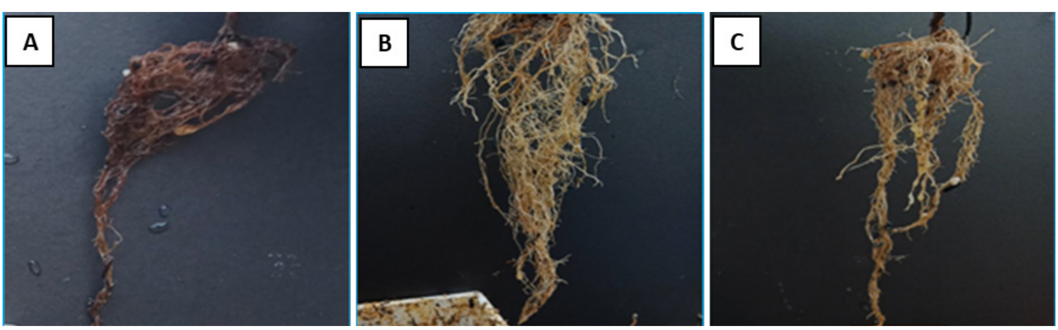


(b)



(c)

Figures 3: Effect of different types of biochar treatment on average (a) shoot dry weight, (b) root dry weight, and (c) root-to-shoot ratio of *L. angustifolia.* PHB = paddy husk biochar; CSB = coconut shell biochar. The error bar represents the standard error. Means with the same letter are not significantly different from each other ($p > 0.05$)



Figures 4: Fresh roots of *L. angustifolia* seven weeks of transplanting into growing media. (A) Control media, (B) PHB = paddy husk biochar, and (C) CSB = coconut shell biochar

Although seven weeks was a very short period for planting *L. angustifolia* and may not well present the whole growth cycle of the plant, the outcome of this study proved that *L. angustifolia* is able to survive in a tropical climate at low sea level. According to Calderwood (2017), lavender can tolerate long, dry, hot summers, and well-draining soil. The positive effects of adding biochar, mainly PHB, in the growing media consisting of 30% soil and 70% sand, if compared to the control indicates that organic matter is important to support *L. angustifolia* growth and establishment, which is aligned with a study on effects of fertilizer on lavender productivity by Komnenić *et al*. (2020). According to Huang and Gu (2019), the growth of plants using biochar in containers is influenced by many factors, including plant species, type of biochar and the ratio of biochar to other media components resulting in various results on plant growth. Their findings pointed out that having a high percentage of biochar, at least 50% by volume, can improve plant growth conditions. Saeed *et al*. (2019) extensively studied the properties of rice husk biochar and coconut coir biochar. Their findings showed that rice husk contained a high amount of silica at 82.50%, while the coconut coir had only 10.50% of silica. However, the coconut coir biochar had a high content of lignin at 43%, while rice husk biochar only contained 17% of lignin. Karam *et al*. (2022) explained that high silica content in rice husk biochar provides better nutrient retention, turgidity and structure for plants.

The positive effects of biochar on lavender growth have been reported by a few researchers. Hashemi *et al*. (2017) found that adding almond wood chips biochar promoted root development and improved plant growth. Fascella *et al*. (2020a) used different combinations of sphagnum peat and coniferous wood biochar on potted lavender. They also reported positive effects of biochar amendments on lavender growth. They suggested that adding 25% conifer wood biochar as a component of peat-reduced substrates displayed adequate physicochemical attributes and improved growth rhythm, physiological activities, pigment biosynthesis, and nutrient uptake. Fascella *et al*. (2020b) concluded that adding conifer wood biochar at high rates, 75% or 100%, did not negatively affect plant growth, essential oil yield, qualitative characteristics, and phytochemical profile. They also recorded high antioxidant and radical scavenging activities of essential oil and hydro-distilled wastewater recorded in plants grown with higher biochar content (Fascella *et al*., 2020b). Hence, this study's findings are concurrent with the effects of biochar on lavender mentioned in previous studies.

In conclusion, the study on the effect of biochar on the growth of *L. angustifolia* in the lowlands was interesting and promising. With the suitable media and care, it is not impossible to plant *L. angustifolia* on a large scale in a lowland area of Malaysia for ornamental, drying products and culinary applications. Hence, a more extended study is required to allow for comprehensive observations on the effect of biochar on lavender growth in the lowlands of Terengganu.

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