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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2021 18(1): 830-837. **OPEN ACCESS**

Effect of treatment of coconut water, red onion extract and *aloe vera* extract on survival and growth from stem and leaf cuttings of meranti bakau (*Shorea uliginosa* foxw.)

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This study aimed to evaluate the effect of treatment of coconut water, red onion extract and aloe vera extract on the percentage of survival and growth from stem and leaf cuttings of meranti bakau (*Shorea uliginosa* foxw.). This research was in the form of a randomized randomized block trial, consisting of control treatment (without immersion of complex organic compounds), coconut water treatment (25, 50, 75, 100%), red onion extract (10, 20, 30%), aloe vera extract (25 %, 50%, 75%). Stem and leaf cuttings were planted in soil media and rice husk charcoal (1: 1; v / v) in polybags covered with plastic. The results showed that all stem cuttings died, while almost all leaf cuttings were still alive. Partial leaf cuttings are able to form roots, but not form shoots. The treatment of natural complex organic materials that can increase the percentage of root formation were the treatment of 50% coconut water and 20% red onion, with a percentage of 50% root formation. All treatments of natural organic complex compounds were able to stimulate root growth, except for the treatment of 25% coconut water and 10% shallot. The best root growth occurred in leaf cuttings treated with 75% coconut water.

Keywords: complex organic compounds, leaf cuttings, plant propagation, *Shorea uliginosa*, stem cuttings

INTRODUCTION

Indonesia has around 18,317,589 ha of peatlands, 6,244,101 ha of which are Sumatran peat. Riau province has the largest peatland in Sumatra, which is around 4,043,600 ha. However, the rate of deforestation of peat forests in Riau is very high, from 50 thousand ha, then increasing to 180 thousand ha in 2005-2006, including activities for making drains (drainage) and burning forests. Fires hit Riau, in 2018 it reached 680.5 hectares (Zamzami and Suryadi, 2018). Damage to the peat ecosystem has a major impact on the loss of hydrological function of peatlands, including causing flooding, and contributing to the highest carbon emissions affecting the global climate (Subiksa et al. 2016). Forest destruction also results in reduced vegetation density and diversity of peat swamp forest (Yulianti et al. 2010). This will threaten the diminishing presence of peat swamp endemic plants. Among the peat swamp forest vegetation that is threatened with extinction is meranti bakau (*Shorea uliginosa*). *Shorea uliginosa* includes peat swamp endemic plants in Riau, including the Kampar Peninsula, Giam-Siak Kecil Bukit Batu, Meranti Islands, and Siak (Jonotoro, 2012; Gunawan et al. 2013; Siadari, 2017. *Shorea uliginosa* included in the list of endangered plants (IUCN Red List or IUCN Red List of Threatened Species) according to the IUCN ((International Union for the Conservation of Nature and Natural Resources). (Jonotoro, 2012). The scarcity of meranti is due to destruction of

peat swamp forests and exploitation which was not matched by planting meranti.

Increased damage to peat swamp forests in Riau has resulted in the existence of meranti bakau plants as endemic to Riau's peat swamp forests. Therefore, efforts must be made to conserve and revegetation of mangrove meranti plants which are important for maintaining biodiversity and restoration on peat (Wahyudi et al. 2014). This effort requires a large supply of seeds. The provision of seeds generally comes from natural uproots (forest tillers) and from seeds. Constraints in providing meranti seedlings include natural uprooting of meranti saplings in forests, which are currently very few (Siadari, 2017) and seeds that are difficult to obtain because meranti plants do not flower every year. Therefore, another alternative is needed for the propagation of meranti plants through stem cuttings, but it is constrained because it requires large amounts of plant material. Apart from stem cuttings, propagation can also be done through leaf cuttings. Propagation through leaves allows obtaining a larger number of seeds than through stem cuttings. Leaf cuttings of succulent plants, herbaceous plants and some woody plants are able to grow to form new roots and shoots due to the presence of meristematic tissue, including cambium on the leaves. Obstacles that inhibit the formation of new roots and shoots on leaf cuttings that are detached from the parent plant include lack of water and growth regulators (Gorelick, 20015). This obstacle can be overcome by giving a lid to the leaf cuttings and soaking it in a growth regulator. Propagation from woody plant leaf cuttings includes citrus plants (Oksana et al. 2012); tea (Subantoro, 2005), coffee (Simatupang, 2013). The growth of leaf cuttings requires the treatment of growth regulators. Growth regulators generally stimulate the formation of root cuttings and shoot growth, but generally are quite expensive. Several natural complex organic compounds from plants can be used as an alternative to growth regulators because they contain natural growth regulators and / or contain natural chemical compounds that can replace the role of growth regulators. Among the natural ingredients that are quite cheap and easy to get are coconut water, onions and aloe vera. Coconut water contains growth regulators for the auxin, cytokinins and gibberellins which are needed to spur root formation and spur shoot formation (Ma et al. 2008).Red onion contain various carbohydrates, protein, minerals, vitamins and various active compounds (Aryanta, 2019). Red onion extract can be used to stimulate the growth of cuttings (Mayasari, 2012; Siregar et al., 2015; Achmad, 2017; Tustiyani, 2017). Aloe vera has various biological activities which are important in medicine and can be used in fertilization to stimulate plant growth. Aloe vera contains various chemical compounds including carbohydrates, vitamins, minerals, amino acids, growth regulators of cytokines (Ni et al. 2004; Habeeb et al. 2007). The treatment of aloe vera gel can increase the growth of vanilla cuttings (Sukerta & Sumantra, 2011). Vegetative propagation from stem cuttings can be done by immersing in coconut water (Aguzaen, 2009; Cabahung et al. 2014; Khair & Hamdani, 2015; Renvillia et al. 2016; Setiawati et al. 2018). However, the effect of these three natural ingredients on the meranti plant leaf cuttings has not yet been provided with any information. This study aimed to evaluate the effect of coconut water, red onion extract and aloe vera treatment on the percentage of survival and growth of meranti plant leaf cuttings.

MATERIALS AND METHODS

The data collection technique was carried out through experimental research, namely planting meranti stem and leaf cuttings in polybags using a randomized block design. The treatments consisted of 11 treatments, namely control (T1), coconut water (25% (T2), 50% (T3), 75% (T4), 100% (T5), red onion extract (10% (T6), 20 % (T7), 30% (T8)), aloe vera (25% (T9), 50% (T10), 75% (T11)). The treatments were tested on stem and leaf cuttings of mangrove meranti. The treatment was repeated 4 times. Therefore, there are 88 experimental units.

Preparation of planting media, natural complex organic compounds and plant material

The planting medium used was a mixture of topsoil soil with rice husk charcoal with a volume ratio of 1: 1 (v/v) (Suryanto et al. 2012). The natural ingredients of coconut water are prepared from young coconut water and made a solution according to treatment through dilution using water. Red onion extract is prepared according to the concentration, for example, for 10% is 100 grams of red onion dissolved in 1000 ml of water then blended and filtered. Aloe vera extract is prepared according to the onion preparation procedure. The origin of the plant material is leaf cuttings, and for comparison it is also done on stem cuttings. Plant material is taken from

seedling of meranti, namely meranti bakau plants from peat swamps from Sungai Apit village, Siak Regency. The stem cuttings were taken in the form of one node. Leaf cuttings were taken from three leaves from the tip (Simatupang et al.20018).

Treatment and planting

The cuttings were then immersed in a solution of organic matter, each according to the treatment for two hours. Furthermore, stem and leaf cuttings are washed with clean water and planted in polybags and covered with plastic in each polybag. The plastic cover was opened at the time of the last observation.

Growth parameters

The final observations were made 10 weeks after planting. Growth parameters observed were the percentage of live cuttings, percentage of shoot formation, percentage of root formation, number of roots, and root length.

Data analysis technique

Observation data were analyzed descriptively in the form of tables of the mean of all growth parameters for each treatment. The data from the observations were not subjected to statistical analysis using ANOVA (analysis of variance) because it did not meet the ANOVA method, that is, most of the results data showed zero numbers.

RESULTS AND DISCUSSION

Percentage of survival, percentage of shoot formation and percentage of root formation

Research on the propagation of meranti bakau (*Shorea uliginosa*) from peat swamps was observed after 10 weeks of planting (2.5 months). The results showed that all stem cuttings had died, whereas most of the leaf cuttings had died.The results of the mean percentage of life, percentage of shoot formation and percentage of root formation from stem and leaf cuttings after 10 weeks of observation are presented in Table 1. The results of the observation on the percentage of survival until the end of the observation (10 weeks after planting) showed that the stem cuttings in all treatments experienced death, whereas leaf cuttings are mostly still alive, indicated by green leaves. Some leaf cuttings are able to form roots, but not yet shoots. Several stem cuttings were able to form shoots after several weeks of planting, but at the end of the observation they had died.

The percentage of survival of leaf cuttings reaches 50 to 100%. Without immersion treatment (control treatment) showed a survival rate of 75%. Most of the natural organic material treatments, namely coconut water, onion and aloe vera were able to increase the percentage of leaf life, which reached 100%, except for the treatment of 25% coconut water and 75% coconut water. Leaves that are still alive but do not form roots are likely to experience death later because a small portion of the leaf shows rot at the base of the leaf and petiole. This is because the petiole is where the roots grow. Some of the dead leaves are indicated by rotting conditions (black color). Leaves that have been released from their parents generally experience rapid aging, but in this study, both control treatment and immersion in natural organic matter showed that the leaves were still green. Planting of leaf cuttings that still have petioles in this study was carried out on the ground in a poly bag that was given a tight plastic lid after watering only once during planting. The cover was given without opening until the end of the observation, which was up to 10 mst. Leaves are still alive and green because the petiole embedded in the ground functions like a stem that can absorb water and nutrients. This is because the petiole has a network of vessels, namely xylem and phloem. Xylem plays a role in absorbing water and nutrients from the soil. Providing a lid prevents evaporation of the leaves and soil, thus preventing drought. These two reasons allow the leaves to remain alive, do not experience aging (yellowing) and are likely to grow into new individuals, namely new roots and shoots.

Leaf cuttings are able to grow to form roots, but not yet shoots. The percentage of root formation in leaf cuttings is from 0 to 50%. The control treatment showed the percentage of root formation reached 25%. Soaking organic matter was able to increase the percentage of root formation by up to 50% only in the treatment of 50% coconut water and 20% onion, while other treatments did not show the percentage of increasing root formation (only 25% living percentage), even treatment of 25% coconut water and 10%. Red onion does not form roots (0%). Provision of coconut water at low concentrations (25% coconut water) inhibits root formation, possibly because the provision of coconut water at such low concentrations is not enough growth regulators in coconut water to trigger root formation, while sugar and other organic matter in coconut water becomes the substrate. For microbes, thus stimulating leaf rot.

Table 1: Average percentage of survival, percentage of shoot formation and percentage of root formation from stem and leaf cuttings 10 weeks after planting (wap)

Treatment	Growth parameters					
	Percentage of survival (%)		Percentage of shoot formation		Percentage of root formation	
	Stem cuttings	Leaf cuttings	Stem cuttings	Leaf cuttings	Stem cuttings	Leaf cuttings
Control	0	75	0	0	0	25
25% coconut water	0	50	0	0	0	0
50% coconut water	0	100	0	0	0	50
75% coconut water	0	75	0	0	0	25
100% coconut water	0	100	0	0	0	25
10% red onion	0	100	0	0	0	0
20% red onion	0	100	0	0	0	50
30% red onion	0	100	0	0	0	25
25% Aloe vera	0	100	0	0	0	25
50% Aloe vera	0	100	0	0	0	25
75% Aloe vera	0	100	0	0	0	25

The live percentage of leaf cuttings of this meranti plant was higher (up to 100%) compared to the propagation study of leaf cuttings in JC oranges (*Japanche citroen*) with a live percentage of 28.33% on sand and 43.334% in soil (Oksana et al. 20120.This because the leaf cuttings of the meranti plant were grown on mixed media of soil and rice husks in plastic covered polybags. Covering using plastic inhibits soil evaporation and transpiration by the leaves so as to prevent the leaves from wilting and drying. In this study the leaves did not experience wilting and dry symptoms. Meranti leaves of 10 weeks (2.5 months) are only able to produce roots, but have not yet produced shoots This result is the same as JC citrus propagation which only forms roots and does not form shoots until the age of 4 months after planting Several studies on plant propagation through Leaf cuttings are generally carried out on succulent and herbaceous plants, while in woody plants not yet abundant k was found. Leaf cuttings without axillary shoots from beetroot (*Beta vulgaris*) are able to form roots at the end of the petiole. Adventitious shoot formation occurs at a very low frequency and is not stimulated by the application of growth regulators. Leaf cuttings with axillary shoots form plants at a higher frequency. Since no vascular connection was found between the petiole and axillary shoots, slow shoot growth was associated with an insufficient supply of assimilation from the leaves. Axillary shoots develop rapidly into shoots when petiole explants with shoots are placed on the growing medium (Miedema et al. 1980).

Roots form on the petiole. Root formation occurs because the phloem and cambium tissue on the petiole undergoes division and differentiation to form roots. Leaves are able to form cathrene roots, leaf primary vessel tissue without secondary growth contains several parenchyma that undergo dedifferentiation (cells undergo division) and then differentiate to form new meristematic areas on leaves that are cut off from the parent. Parenchyma is a plant cell with a thin cell wall (cells with thick cell walls are known as sclerenchyma and cells with medium width cell walls are called collenchyma). Naturally, differentiated parenchyma in the vascular tissue of the leaves often occurs on the stems of succulent plants. The differentiated parenchyma is also seen in particular in the secondary growth of many stems of xerophyte plants with an accompanying phloem. The differentiated parenchyma around the vascular tissue of the leaves is sufficient to grow de novo roots and shoot apical meristems (Gorelick, 20015). Woody plants can experience this if moisture is maintained in the leaf tissue and can be stimulated by growth regulators that stimulate the process of cell division (resulting in dedifferentiation) and differentiation of cells that have divided to form roots. In this study, to maintain moisture and prevent leaf rot, it was carried out through watering only at the beginning of planting and providing a cover until the end of the observation which prevented evaporation.

In this study, the leaves that formed the roots were then replanted with watering and covering them. Leaf cuttings are still alive for up to two weeks after the second planting. The leaf cuttings are expected to grow new shoots later. New root and shoot meristems likely develop de novo from the phloem tissue in detached leaves. The primary phloem of angiosperms in leaves consists of filter reeds (Sieve tube), companion cells (Companion cel), phloem parenchyma, and phloem fibers. Phloem parenchyma is the cells that surround and support the filter reed. Phloem parenchyma may be indistinguishable from companion cells or integrated with cells with companion cells. The development of the incipient apical meristem from angiosperm leaves is probably derived from phloem parenchyma cells or companion cells because phloem parenchyma cells have a thin cell wall, whereas companion cells have a thin cell wall and have a nucleus. However, filter reeds do not contain nuclei and phloem fibers have a cell wall that is thick enough to block cell division. In addition, the leaf cambium meristem also allows for the formation of new roots and shoots, because when attached to the stem, the meristematic activity of the leaf cambium produces new leaf tissue (Gorelick, 20015).

Until the end of observation, the condition of stem cuttings showed symptoms of rot, dryness and mold. The first week after planting, generally the stem cuttings have not rot and died. Stem cuttings generally rot after the third week of planting. Symptoms of stem rot occur because stem cuttings do not grow, the presence of water and the growth of microbes. A small proportion of cuttings were able to form shoots, including 25% of the coconut water treatment of 25 and 50%, and 75% of aloe vera treatment. For example, on cuttings that are treated with 25% coconut water, shoots appear about 2 weeks of planting, then shoots grow elongated and new leaves grow, but at week 6 the stalks wilt, followed by wilting of shoots, then die at 8 weeks.which grows thereafter withers and dies. Because the soil is still moist, the shoots are wilted, possibly because the base of the stem does not grow into roots and rot, so the function of water and nutrient absorption does not work.

Meranti stem cuttings in the study did not form roots probably because the cuttings planted consisted of only one node and without leaves. Stem cuttings will likely grow into roots if the number of nodes is increased and leaves are present. In addition, another alternative to spur the formation of stem cuttings is to use apical stem cuttings, which still have meristematic tissue. Propagation through stem cuttings on various woody plants can grow to form roots and shoots. The growth and development of *Jatropa curcas* stem cuttings is influenced by the length and basal area of the stem cuttings. Shorter cuttings promote shoot formation, but longer and thicker cuttings promote root and shoot growth. Cuttings originating from the basal part of the branches grow better than stem cuttings from the middle and tip branches (Severino et al. 2011).

Number of Roots and Root Length

The mean results of observations on the number of roots and root lengths of 10 mst stem and root cuttings can be seen in Table 2. Stem cuttings died and did not grow roots. The variables of the number of roots and root length were only counted on repeated root cuttings. Leaf cuttings that form roots show the number of roots formed ranging from 1 to 24 roots. The root length ranges from 0.75 to 8.5 cm. Based on the results presented in Table 2, it shows that the treatment of soaking leaf cuttings in coconut water, shallots and aloe vera can increase root growth. Coconut water treatment was able to increase root growth at concentrations of 50, 75 and 100%, and the best root growth was at 75% coconut water treatment. The treatment of 20 and 30% shallots were able to increase root growth, and showed the best growth, with high number and length of roots, with 18 and 14 root numbers, and 5.45 and 4.15 cm root lengths, respectively. Treatments of 25, 50 and 75% aloe vera were able to increase root growth, with the best growth at a concentration of 10%. The overall results showed that the highest number of roots and root lengths occurred in leaf cuttings which were treated with 75% coconut water immersion with 24 roots and the root length reached 8.55 cm. The explanation of the results of this growth is shown by the leaf cuttings morphology shown in Figure 1.

The highest percentage of root formation (50%) occurred in the treatment of 50% coconut water and 20% shallot but the root growth in that treatment was still very low. The highest root growth occurred in cuttings that were treated with 75% coconut water, but the percentage of root formation was still low, namely 25%. This is probably because the growth inhibitor contained in these natural ingredients is not optimal yet to spur root formation, root growth and spur shoot formation.

Table 2: Average number of roots and root lengths of leaf cuttings 10 weeks after planting

Treatment	Growth parameters		
	Number of roots	Root length	Root growth
Control	1	1,2	+
25% coconut water	-	-	-
50% coconut water	4	0,75	++
75% coconut water	24	8,55	++++
100% coconut water	1	2,75	++
10% red onion	-	-	-
20% red onion	18	5,45	++++
30% red onion	14	4,15	++++
25% Aloe vera	12	4,75	++++
50% Aloe vera	2	1,25	++
75% Aloe vera	3	1,95	+++

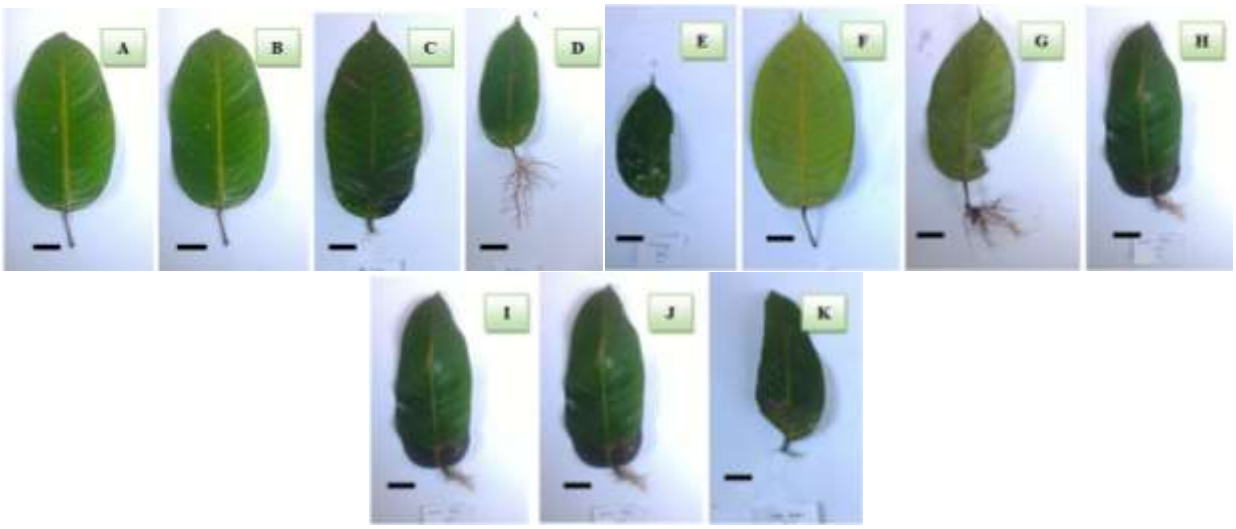

Figure 1:Morphology of leaf cuttings at the end of the observation in various treatments: (A) Control; (B) 25% coconut water; (C) 50% coconut water; (D) 75% coconut water; (E) 75% coconut water; (F) 10% red onion; (G) 20% red onion; (H) 30% red onion; (I) 25% Aloe vera; (J) 50% Aloe vera; (K) 75% Aloe vera. Scale: 2 cm

To increase the percentage of root formation, promote root growth and promote shoot formation in leaf cuttings, it is possible to increase the use of synthetic growth regulators, either alone or in combination with several natural ingredients, such as coconut water, red onion and aloe vera.

CONCLUSION

All stem cuttings died, while most leaf cuttings were still alive. The treatment of complex organic compounds was able to increase the percentage of survival up to 100%.Partial leaf cuttings are able to form roots, but not shoots. The treatment of natural complex organic compounds that was able to increase the percentage of root formation was the treatment of 50% coconut water and 20% onion, with a percentage of 50% root formation. All natural ingredients treatments were able to stimulate root growth, except for the treatment of 25% coconut water and 10% red onion. The best root growth occurred in leaf cuttings treated with 75% coconut water.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The author's gratitude goes to the Faculty of Mathematics and Natural Sciences, Universitas

Riau for the support and assistance with research costs through DIPA funds, the Faculty of Mathematics and Natural Sciences, Universitas Riau.

AUTHOR CONTRIBUTIONS

SF contributes to research design, conducts research and completes research papers. S contributed to assisting the preparation of proposals, research materials and research papers.

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