Growth and Biomass of *Anthocephalus cadamba* Seedlings in Response to Liquid Disposal of Particleboard's Recycling as Fertilizer

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Abstract: Liquid disposal (LD) originated from particleboard bonded by urea-formaldehyde (UF) resin's recycling contains nitrogen which can be utilized as fertilizer for non-food seedlings. This study focused on the analysis of growth and biomass of *Anthocephalus cadamba* seedlings, one type of local Indonesian plants which is popular for forest plantation, after application of fertilizer made of LD of particleboard's recycling. Methods of this work were consisted of analysis of the LD, analysis of soil, preparation of growth media, application of the LD's fertilizer to the seedlings, and observation of the growth parameters and their biomass. Result of this study showed growth parameters namely plant height and diameter of *A.cadamba* were significantly enhance after exposure of LD's fertilizer. However, biomass parameters such as dry weight of roots and top/roots ratio did not influence. This finding suggested that fertilizer made of LD originated from particleboard bonded by UF resins can be utilized as fertilizer for seedlings particularly for topgrowth.

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1 INTRODUCTION

At present, modern furniture and household have been predominated made of panel products, such as plywood, fiberboard, and particleboard (Peng and Riedl, 1995; Youngquist, 1999). These products are bonded mainly by urea-formaldehyde (UF) thermosetting resins which made of urea and formalin (Dunky, 1998).

Initially, UF resin was synthesized at mole ratio of formaldehyde to urea (F/U) about 1.6~1.8 in manufactures and resulted in good bonding strength of wood products. However, because of formaldehyde emission and discomfort leading to health disruption as well as prerequisite of standard emissions, low mole UF resin started to be applied in industry nowadays (Dunky, 1998), *i.e.* around 1.1~1.2. Therefore, strength of these products relatively decreased thus susceptible to the destruction. In this regards, waste of panel products are abundant originated from old broken particleboard's furniture such as cupboard, table-top and kitchen set as well as out-lived particleboard's non-structural building components, for instances insulation, partition, wall and sheathing.

Currently, three options were recommended for dealing with wood waste consisting of land-filling disposal, incinerating, and recycling. The first two have effect to air, water, and soil. The last option almost has no environment impact (European Commission, 1997).

Recycling treated wood including wood particle induced to adhesive in panel products is not a new concept. Several studies discussed the process of particleboard's recycling, for example study of Czarnecki et al (2003); Varga et al. (2004); Lykidis and Grigoriou (2008). Many studies have been also dealt with the solid residue from particleboard recycling, its utilization for making recycle-products and their quality, such as work of Huang et al. (2004); Huang and Wang (2005); Gong (2007); Gao et al. (2014).

When UF resin is used as adhesive, it contains several components which is called chemical cluster, such as macromolecules, polymer networks, including sol fractions. Sol fraction is the unlinked polymer chains and not attached in the network therefore they can be extracted (Nuryawan et al. 2014). Recently, Lubis et al. (2018) reported that water could be used as hydrolysis agent for fiberboard recycling. They reported that both in solid residue and extract solution contained nitrogen (N) derived from UF resin adhesives. In this context, recycling of particleboard bonded by UF resins

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using water soaking is feasible and the liquid disposal (LD) originated from particleboard's recycling activity could be utilized as fertilizer because it contains N (Singh et al., 2015) as the source of the nutrients for the plant.

Here, we will report the responses of the growth parameters of *Anthocephalus cadamba* seedlings, one type of local Indonesian non-food plants which is popular for forest plantation, after application of LD of particleboard's recycling activity. Thus, the objective of our present work is to evaluate the growth and biomass responses of the *A.cadamba* seedlings in comparison to that of the ones after treatment of LD in various F/U mole ratios of UF resins.

2 MATERIALS AND METHODS

2.1 Materials

Particleboards made of gmelina (*Gmelina arborea*) wood having 10% different types of binder of UF resins, namely F/U mole ratios of 0.95; 1.05; 1.15; 2.0; and commercial were used as source of recycling material.

Mature and healthy seedlings of *A.cadamba* were brought from the nursery at Pancur Batu, North Sumatra, Indonesia were used as research object.

2.2 Methods

2.2.1 Recycle and hydrolysis of particleboard

Simple soaking method in ambient temperature water was applied for recycling the particleboard. The principle of this method is hydrolysis of UF resin within particleboard thus easily to get both wood particle solid residues as well as extract solution containing N originated from sol fraction of the UF resin. Later, the extract solution or LD was used as fertilizer.

The procedures are as follows: first, particleboards were cut about 5 cm x 5 cm x 1 cm and then classified according to the binder used. Second, five small sample of the each binder particleboards were soaked in a bath containing 1000 ml room temperature water until they were broken for hydrolysis process. Indeed, for each binder, it needs different periods of soaking. For example F/U mole ratio of 0.95; 1.05 and 1.15, they took 2-3 days while F/U mole ratio of 2.0 and commercial UF adhesive took 8-10 days (Siringo-ringo, 2017). Third, after hydrolysis, for separation between the wood particle solid residue and the LD, a filter paper (Whatman No. 1, Ø: 90 mm) was used. Fourth, the LD was dissolved in 9000 ml water, kept in the gallon, analyzed the N content then it was ready to apply as fertilizer. Analysis of the N content used titimetri method and carried out in Laboratory of Indonesian Oil Palm Research Institute, Medan, North Sumatra, Indonesia. Results of the N content are shown in Table 1.

Table 1: N content analysis of LD of particleboard's recycling

LD originated from UF resin with	N content (%)
F/U mole ratio of 0.95	689.94
F/U mole ratio of 1.05	1042.67
F/U mole ratio of 1.15	969.65
F/U mole ratio of 2.0	462.43
Commercial	128.04

2.2.2 Media and seedlings preparation

Prior to evaluate, the seedlings were moved and planted in polybag using soil as media having poor nutrients originated from arboretum Universitas Sumatera Utara (USU) as shown in Table 2.

Table 2: Criterion of soil from arboretum USU used in this study according to assessment published by Soil Research Center (1983)

Parameter	Value	Remarks
pH	5	acid
C-organic (%)	1.32	low
P available (ppm)	15.45	low
N total (%)	0.14	low
K available (m.e/100g)	0.46	moderate

Preparation of media consisted of: first, air dried soil was sieved using 2 mm in size. Second, base fertilizer composed of 3 g SP 36 and 2 g KCl were put on the base of polybag. Third, each seedling of *A.cadamba* was planted in the polybag with 3 kg of prepared soil and put in a greenhouse of Faculty of Agriculture, USU, Medan, Indonesia. Total of polybag containing *A.cadamba* seedling was 30, consisted of 6 treatments of LD with 5 replications, namely control, F/U mole ratio of 0.95; 1.05; 1.15; 2.0 and commercial.

2.2.3 Treatment and Observation

Cultivation of the seedlings was carried out by watering in the morning every day for 12 weeks. Treatment was applied by giving the LD with 75 ml in dosage every week for each treatment except for the control.

Observation was done for measuring growth parameters, consisting of stem height and diameter of the seedlings. These measurements were conducted every week but only the data of measurement of 9, 10, 11 and 12 weeks after planted were used for statistical analysis.

Biomass measurement was determined by destructive sampling techniques. Each seedling was partitioned into top and root components to weigh prior to drying. Top components were composed of shoots, leaves and stem. The seedling biomass was measured from dry weights of top and roots of each plant which were determined separately on an analytical balance, after drying in an oven at 70 ºC for 48 h. The weights recorded once a constant weight was reached. From these measurements, we calculated wet and dry weight of top and roots of individual seedling then compare to get the ratio.

2.2.4 Statistical analysis

The data were analyzed by one-way analysis of variance (ANOVA) followed by Dunnett's test for comparisons of all treatments (LD originated from UF resin) against the control. The values of $p < 0.05$ was selected as the thresholds of statistical significance. All of the statistical analyses were performed using the SPSS statistical software program.

3 RESULTS AND DISCUSSIONS

Even though *A.cadamba* is a native forest species of South and Southeast Asia (Orwa et al., 2009) but it has been cultivated widely in Indonesia, such as in West Java, East Java, South Kalimantan, Sumatra, Sulawesi, West Nusa Tenggara, and Papua (Martawijaya et al., 1989).

In this regards, evaluation of growth seedling of this species in North Sumatra with specific treatment using LD originated from particleboard recycling was carried out.

3.1 Effect of LD to The Seedlings Height

In this experiment, means of growth height of *A. cadamba* seedlings after 9, 10, 11 and 12 weeks after planted as presented in Table 3.

Table 3: The average of seedling height (cm) of *A. cadamba* in various weeks after planted

Weeks / Treat-Ment	9	10	11	12
Control	6.72	7.54	8.12	8.62
0.95	10.18A	13.26B	15.38C	17.66D
1.05	10.64A	13.46B	15.34C	17.52D
1.15	10.44A	12.96B	14.92C	16.72D
2.0	10.92A	13.02B	14.38C	16.64D
Commercial	9.14A	10.00B	11.00	11.60

Remarks: means not labelled with the same letter were significantly different from the control.

Table 3 showed that the height seedling was influenced by LD treatment particularly in 9 and 10 weeks after planted. When period of planted was lengthen, LD originated from commercial UF adhesive was meaningless for height growth. Indeed, the N content of LD from commercial UF resins was the lowest, only 128% (Table 1). This performance was in line with the statement of Sarjono et al (2017) that *A. cadamba* or white jabon has significant performance on early growth of cultivation.

3.2 Effect of LD to The Seedlings Diameter

Means of diameter growth of *A. cadamba* seedlings after 9, 10, 11 and 12 weeks after planted were tabulated in Table 4.

Table 4: The diameter average of seedling of *A. cadamba* in various weeks after planted

Weeks / Treat-Ment	9	10	11	12
Control	0.28	0.30	0.32	0.36
0.95	0.50A	0.58B	0.65C	0.71D
1.05	0.43A	0.53B	0.60C	0.67D
1.15	0.45A	0.53B	0.60C	0.67D
2.0	0.38A	0.46B	0.52C	0.57D
Commercial	0.39A	0.44	0.48	0.54

Remarks: means not labelled with the same letter were significantly different from the control.

Table 4 exhibited that the seedling diameter growth was influenced by LD treatment particularly in 9 week after planted. When period of planted was lengthen into 12 weeks, LD originated from commercial UF adhesive resulted in same tendency of the seedling height. Commercial UF resin with

low N content of sol fraction did not affect significantly to the diameter growth of seedling particularly when the period of planting was lengthen.

3.3 Effect of LD to Biomass

Means of biomass of *A. cadamba* seedlings part of top, root, and ratio of top/root after 12 weeks after planted were exhibited in Table 5.

Table 5: The average of seedling biomass of *A. cadamba* in various part (top and root) at 12 weeks after planted

Weeks / Treat-ment	Top	Root	Ratio of Top/Root
Control	13.11	4.42B	6.28C
0.95	32.77A	11.16B	8.61C
1.05	38.64A	12.01B	6.68C
1.15	35.90A	17.37B	6.84C
2.0	29.27A	14.16B	7.38C
Commercial	22.82	11.45B	6.23C

Remarks: means not labelled with the same letter were significantly different from the control.

Table 5 showed that the top biomass of seedling was affected by LD treatment except the commercial one. However, root biomass as well as ratio of top/root did not affect significantly. This experiment proved that LD containing high N content sol fraction can be utilized as the fertilizer for seedling particularly for the top part (shoot, leaves, and stem).

4 CONCLUSIONS

Growth parameters namely plant height and diameter of *A.cadamba* were significantly enhance after exposure of LD's fertilizer. However, biomass parameters such as dry weight of roots and top/roots ratio did not influence.

This finding suggested that fertilizer made of LD originated from PB bonded by UF resins can be utilized as fertilizer for seedlings particularly for top growth, particularly for *A.cadamba* seedling, a non-food plant.

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