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Identification and Decomposition of Five Dominant Wild plants from Acid Swampland in South Sumatra

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ABSTRACT

There were five emergence plants in swampland such as *Polygonum barbatum*, *Neptunia prostrata*, *Phragmites karka*, *Ludwigia adscendens* and *Phragmites communis,* which might be used for compost source, all the plants were easily adapted and grew very well on acid soil. These plants were choosen because of abudancy and size. All plants were identified, collected, chopped and weighted then put in a 50 liters plastic drum for decomposting during 12 weeks. Composts temperature were monitored every week, nutrients content (N, P, K, Ca, Mg, Na) and compost chemical properties (C-organic, C.E.C., C/N ratio) were analysed every two weeks. Results showed that each compost from different plant varied in nutrients content and chemical properties. Compost made of *Neptunia prostata* Lam. contained highest nutrients than others, it's nutrients were N (4%), P (1675 mg kg^{-1}), K (5.6 %), Ca (0.32 %), Mg (0.32 %) and Na (0.12 %) and the lowest nutrients content showed by compost of *Phragmites karka* Retz. in which N (2.4 %), P (1160 mg kg^{-1}), K (2.62 %), Ca (0.04 %), Mg (0.07 %), and Na (0.03 %). It seem broadleaf plants tended to have higher nutrients content than grasses or graminae. *Neptunia prostrata* compost had a high N content due to it's leguminosae plant. Al and Fe were low in all composts, therefore all plants were recommended for organic nutrient sources.

Keywords: Swamp, plant, compost, nutrient, acid, soil

INTRODUCTION

There are a lot of wild plants in swampland at South Sumatra, previous study have used floating wild plants for compost such as water ferns and hycinths, which have been applied for rice growing on bamboo rafts, the application of 10 Mg ha^{-1} of this compost produced 91% filled spikelets or 19,14 g/cluster (Bernas *et al*. 2012) and similar result recommendation of hycinth composts for rice by Gaue 1980 *in* Hesse 1984.

Beside floating plants, there are also many other emergence plants in swampland such as *Polygonum barbatum*, *Neptunia prostrata*, *Phragmites karka, Ludwigia adscendens and Phragmites communis*, which can be used as compost. All the plants adapt and grow very well on acid soil and acid water in floodplain area of Musi River and it's tributaries in South Sumatra. Tolerable plants grew on acid soils by accumulated Al and Fe on the roots (Shazana *et al.* 2014) and did not easily translocate to the shoots and Al in the roots of tolerant plants did not limit the uptake and translocation of Ca, Mg and P (Foy 1964). If this swamp plants could be used as compost and applied to cultivated plant this could be very worthy, because this plants absorb nutrients from acid soils, the plants can act as nutrients bridging for plant growth, since crop plants can not grow well in acid soils.

Characteristics of soil and water in swampland mainly from very acid (pH <3.0) to acid (pH 4.6) but during flooding pH can be about 6,0 this was caused by leaching and diluting; very low nutrients content and also contain FeS in some soils (Naning *et al.* 2008; Sagala and Bernas 2008). Paddy could not grow during rain season because water is too deep and acid, that why farmers grow rice in the end of rain season where water level is low enough for planting paddy, only wild plants grow in this swampland during flooding time.

This swampland have been planted for paddy about 184,079 ha once a year, about 6,708 ha twice a year and 106,113 ha had not been used and mainly covered by wild plants (Subiksa and Ratmini 2007). Many kind of wild plants such as: trees, grasses, shrubs, and ferns have adapted very well in this acid lowland, several wild plants or weeds also grow on the paddy field after rice harvesting.

In South Sumatra some of the wild plants have not been characterized and used for compost, eventhough this plant materials contain nutrients, then wild plants can be used as nutrient sources. During dry season this wild plants usually are burned and grow again in rain season. Thus it is better to harvest wild plants for compost and this can help farmer in decreasing amout of inorganic fertilizers application.

The purpose of this research was to evaluate the abundancy of swamp wild plants and the potential of this plants for compost sources.

MATERIALS AND METHODS

Identification and survey of wild plants were carried out at two sites on swampland in Districts of Pemulutan and Rambutan, Ogan Ilir Regency, South Sumatra. Five dominated wild plants *i.e.*, joint weed (*Polygonum barbatum* L.), water mimosa (*Neptunia natants* Lam.), reed (*Phragmites karka* Retz.), Francais Khmer Lao (*Ludwigia adscendens* L.) and Reed (*Phragmites communis* Trins) were selected among other weeds and collected for compost. This plants were considered for compost based on abundance and size of canopy, the dominated plant was not included if too small. Plant identification was based on Corner (1969) and Soerjani *et al.* (1987).

Each plant was cut into small pieces using a chopper machine, then weighted and put into a 50-liter plastic bucket with lid and put a small tube for air. Each material was incubated in room temperature for 3 months, temperature and water content were monitored during incubation. Every four weeks, compost was taken for nutrients, carbon, and C.E.C. analysis, C-organic (Walkley and Black Method), N (Kjedahl Method), C.E.C. and K, Ca,Mg, Na, Fe and Al (NH_4Oac at pH 7,0 method) and P (Bray-I). All samples were analysed in Soil Chemical Laboratory, Agriculture Faculty, University of Sriwijaya.

RESULTS AND DISCCUSSION

Identified Swampland Plants

Based on field investigation and nomenclature, there are five plants having potential for compost sources *ie*. *Ludwigia adscendens, Neptunia prostrata* (Water mimosa), *Phragmites karka* (Reed), *Phragmites communis* (Reed), *Polygonum barbatum* (Joint weed). Characteristics of these plants are presented in Table 1. The plants were choosed because of abundancy, size and height of plant canopy, thus it is easy to gather in a big amount.

All the plants are as emersed aquatic macrophytic weeds, growing in shallow water or wet soil according to Roger and Watanabe 1984. These weeds are growing in rice field during flooding on rain season, where farmers do not plant paddy due to deep water.

These plants contained water differently, dicotyle plants tended to have higher water content than monocotyle. *Ludwigia adscendens* L. contained very high liquid (88.67%) and this liquid was rather sticky, slimy and achy on the skin but other plants do not contain this liquid (Table 2). Because of this, making compost will be suitable on the paddy field for absorbing the liquid but not in the bucket. Plant water content is important in consideration for compost production, if water content is too high then compost product will be low. However, all this plants contain about 20% differences in water content, thus the different were not really much for making compost.

Compost Temperatures During Decomposting

During decomposting, temperature started raising from the first week up to 4^{th} week of incubation time, then tended to lower to 28 °C up to 12 weeks of incubation (Figure 1). Actually, temprature started increasing from the second day of incubation time, it was recorded about 37 °C on average. It meant the decomposition processes had started very early and fastest rate in the first five weeks, following by slower rate of decomposition. Similar Research had been done by Munawar *et al.* 2011 found that decomposition processes had started fastest in the first two weeks. High temperature in the first five weeks of incubation indicated the first time materials decomposed containning were readily available small molecular weight subtrates such as sugars, amino acids, and aliphatics acids which metabolized within a few hours or days (70% lost in the first weeks), and most proteins and polysaccharides are also rapidly utilized but at slower rate, (lima bean straw 36% in the first week and 57% C was lost and wheat straw was about 26% lost in the first week, 45% in 4 weeks (Martin and Haider 1986).

Further, temperature was about 28 °C still in the range of optimum for decomposition processes, research was done by Reeves *et al.* 2012 showed that mineralized C was higher in 21 °C temperature than in 14 and 17 °C. Hooker and Stark 2012 found seasonal in microbial C and N turnover rate which were high on summer and low on winter time. When the temperature was about 28 °C, it meant decomposition process was still occured up to 12 weeks of incubation especially for *Phragmites karka*

Table 1. Properties of wild plants used for compost.

No.	Name	Plant Properties
1.	*Ludwigia adscendens* L. (Francais Khmer Lao)	Aquatic, annual herbs, partially submerged, stems end branches grow up to 1 m long, free floating and rooting in the substrate, stolon present, rooting at the nodes. Roots white, fibrous and with spongy floating organs. Stems rounded, solid, glabrous. Stipules present, triangular, glabrous. Simple leaves , entire, alternate, more than 2 cm long/wide, glabrous, entire margin, apex rounded, base attenuate, pinnately veined. Bisexual flowers, solitary, axillary, stalked or sessile, small, less than 2 cm, 5 petals, white. A capsule Fruit, opening irregularly.
2.	*Neptunia natans* Lam. (Water mimosa)	Aquatic perennial herb, floating or prostrtae near the water edge. Stems up to 1.5 m long, branched, older parts of the stem enveloped by a thick spongy layer of white aerenchyma tissue, emiiting fascicles of roots from nodes. Pinnae 2-3 pairs, 2.5-4.8 long; leaflets 1-16 pairs; linier, dark green with purple margin. Flowers yellow, 30-50 per spike and sessile. Pod broadly oblong, flat, glabrous, 1.5-3 cm x 0.8-1 mm boroad; seeds 4-8 per pod, brown, compressed, 4-5 × 2.5-3.5 mm.
3.	*Phragmites karka* Retz. (Reed)	A reed plant, commonly forms extensive stands, which may be as much as 1 square (0.39 sq mi) or more in extent. It grow in swampland with water up to 1 m or deeper. The erect stems grow to 2–3,3 metres tall. The leaves are long for a grass, 20–50 cm and 2–3 cm broad. The flowers are produced in all year around, dark purple panicle, about 20–50 cm long. Later the numerous long, narrow, sharp pointed spikelet appear greyer due to the growth of long, silky hairs.
4.	*Phragmites communis* Trin. (Reed)	A reed, up to 4 m high, with hollow stem, in marshy places and river banks. Leaf -60 × 2-3 cm. Panicle large, plumose silky, purplish brown (Corner, 1969).
5.	*Polygonum barbatum* L. or Joint weed	Herb, leaves simple, alternate, entire, stipule usually scarous and sheathing the stems. Plant slightly pubescent or nearly glabrous, 30-60 cm high, raceme irect, 2-6 cm long, nutlets trigonous, peduncled (2-6 × 0.5-0.7) cm, the bracts close, ciliate; perianth white, about 2 cm long. Nutlet trigonous, shining 1.75 long.

Table 2. Water content of chopped plant before composting

Plant Name	Plant water content (% fresh weight)
Phragmites communis Trin. (Reed)	68,47
Neptunia prostrata Lam. (Water mimosa)	84,12
Phragmites karka Retz. (Reed)	65,99
Ludwigia adscendens L. (Francais Khmer Lao)	88,67
Polygonum barbatum L. (Joint weed)	74,26

Retz. (Reed) and *Phragmites communis* Trin. (Reed) which are graminae family indicated by C/N were rather high (Figure 2).

Compost Chemical Properties

C-organic contents after 12 weeks of incubation are still very high (about 40%) in compost of reeds and about 30% in compost of *Neptunia natans* Lam. and *Ludwigia adscendens* L. (Figure 3). This results indicated that graminae plants were decomposed slower than broad leaf plants, it could be due to graminae plants contained more lignin than broad leaf. As reported by Nahrawi *et al*. 2011 that C/N ratio and lignin was the best chemical predictor of litter decomposability. The indication of slow rate decomposition on graminae plants also showed by

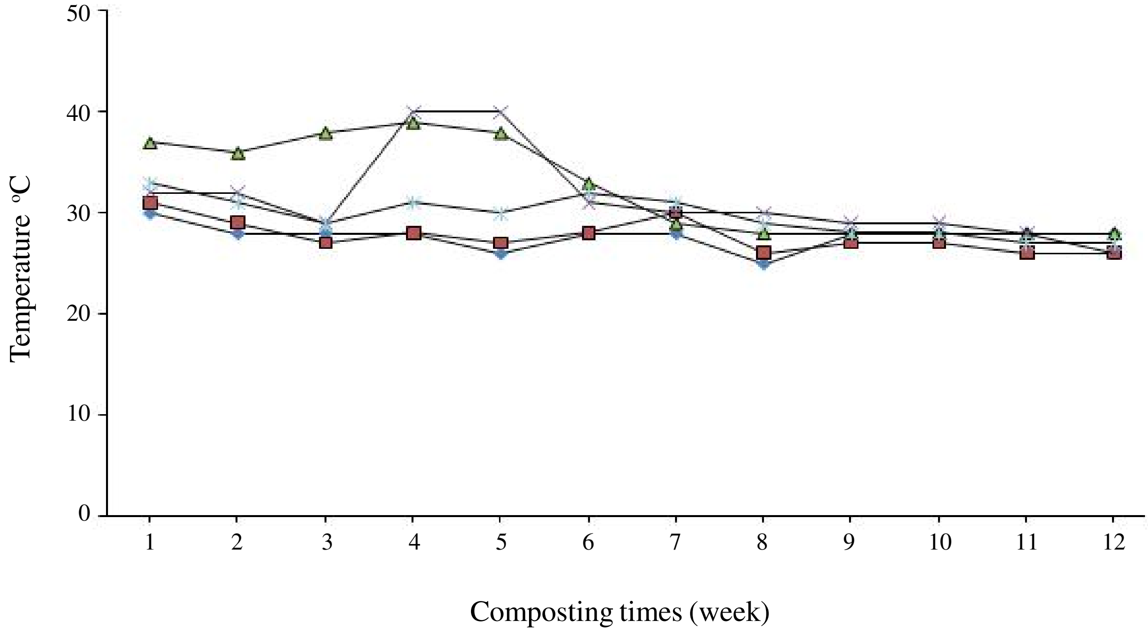

Figure 1. Compost temperature (°C) during incubation. —◆— : *Ludwigia adscendens* L. ; —■— : *Neptunia natans* Lam. ; —▲— : *Polygonum barbatum* L. ; —×— : *Phragmites communis*.; —✳— : *Phragmites karka* Retz.

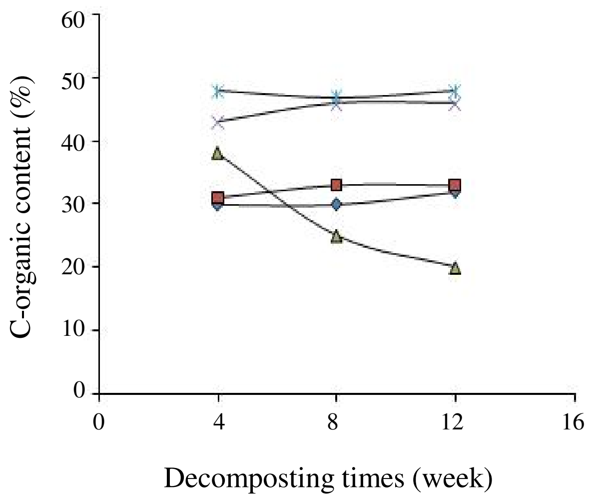

Figure 2. C-organic content in compost after 4, 8 and 12 of incubation weeks. —◆— : *Ludwigia adscendens* L. ; —■— : *Neptunia natans* Lam. ; —▲— : *Polygonum barbatum* L. ; —×— : *Phragmites communis*.; —✳— : *Phragmites karka* Retz.

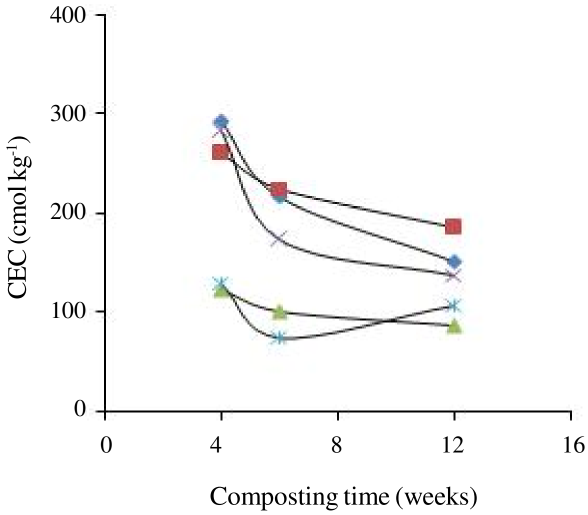

Figure 3. Cation exchange capacity in compost after 4, 8 and 12 of incubation weeks (CEC). —◆— : *Ludwigia adscendens* L. ; —■— : *Neptunia natans* Lam. ; —▲— : *Polygonum barbatum* L. ; —×— : *Phragmites communis*.; —✳— : *Phragmites karka* Retz.

C/N ratio, which were about 40 in the 4th week of incubation and about 20-30 in the 12th week. When comparing to broadleaf plants, *Neptunia natans* Lam. and *Ludwigia adscendens* L. had low C/N (about 10 in the 4th week and <10 in the 8th and 12th weeks of incubation. It meant decomposting processes for broadleafs were only for 4 weeks but more than 12 weeks for graminae plants.

Composts made of *Neptunia natans* Lam. and *Ludwigia adscendens* L. contained N (about 2.5 to 3) in the 4th week and increased up to 3 to 4% in the 12th week of incubation, while compost of graminae had 1.0 to 1.5% Nitrogen in the 4th week and increased to 1.5 to 2.5% in the 12th weeek as shows in Figure 4.

Nitrogen content in compost from different aquatic plants increased from about 3% to about

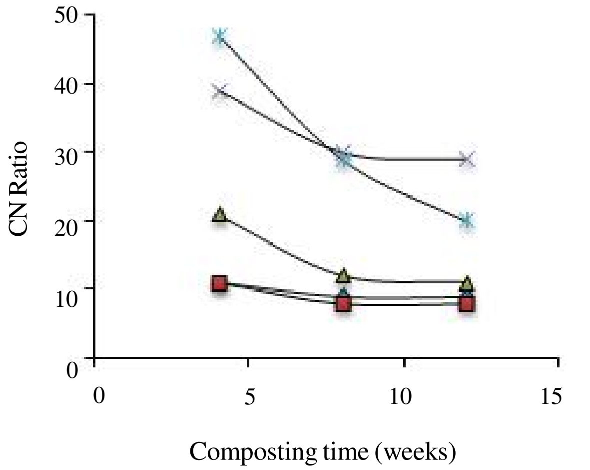

Figure 4. CN ratio after 4, 8 and 12 weeks of incubation. —◆—: ludwigina; —■—: neptunia; —▲—: polygonum; —×—: phragmites c.; —✱—: phragmites k.

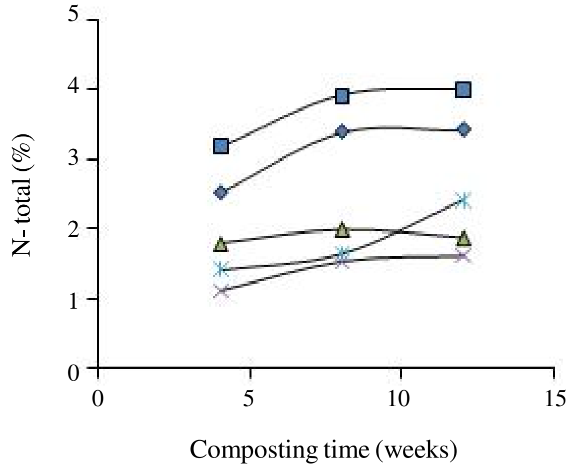

Figure 5. Nitrogen in compost after 4, 8 and 12 weeks of incubation. —◆—: ludwigina; —■—: neptunia; —▲—: polygonum; —×—: phragmites c.; —✱—: phragmites k.

4% in 4 weeks of incubation to 12 weeks, but N increased sharply in 4 and 8 weeks of incubation. Time of incubation was similar to finding by Nett *et al*. 2012 when organic matter added to the soil, soil mineral N started increasing from 3 days to 47 days after starting incubation. The results showed that *Neptunia prostrata* Lam. Contained the highest N, it was understandble because this plant was an aquatic mimosa (legume) that has an ability to fix N from the air, as shown by visible noodles in the roots.

However, when groundnut straws incorporated into the soil, N could loss as N_2O (12.2 mg m^{-2} day^{-1}) to the air reported by Kaewpradit *et al*. 2008. So it was not only CO_2 losses but also some of N_2O, that why C/N ratio was not really accurate in measuring the rate of decomposition, eventhough it's still used for a simple indicator instead of using a radioactive.

The results showed that CEC of compost made of Ludwiginia, Neptunia and Polygonum (broade leaf plants) were very high (about 250 to 300 cmol kg^{-1}) at the 4th week then decreasing to about 150 to 200 cmol kg^{-1} at the 12th week of incubation (Figure 5). These CEC were higher than compost made of two graminae Phragmites (reeds) which were about 120 cmol kg^{-1} at the fourth week and about 100 cmolkg^{-1} at the 12th week of incubation. So composts made of broad leaf plants could contain high amount of humic substances because CEC of humus were between 300 to 550 cmolkg^{-1} as reported by Jenkinson 1988. These compost might be very ideal for increasing soil CEC and aplication of the compost could be suggested in acid swampland, which can act as ligand in soil having high Al and Fe.

Macro Nutrients Content in Compost

Results showed that P, K, Ca, Mg and Na contents in each compost were varied, indicating every plant had different in nutrients composition and potassium was higher in all composts comparing to other nutrients (Table 4).

Table 4. Nutrients content in compost after incubation for 12 weeks

No	Name	P-Bray (mgkg^{-1})	K	Ca	Mg	Na
			(%)			
1.	*Neptunia prostrata* Lam. (Water mimosa)	1675	5.6	0.32	0.32	0.12
2.	*Ludwigia adscendens* L. (Francais Khmer Lao)	1454	5.00	0.90	0.02	0.04
3.	*Phragmites karka* Retz. (Reed)	1160	2.62	0.04	0.07	0.03
4.	*Phragmites communis* Trin. (Reed)	827	3.75	0.29	0.06	1.10
5.	*Polygonum barbatum*	270	3.09	0.91	0.07	0.23

Table 5. Iron and Alummunium content in compost

No	Name	Fe	Al
		(mgkg^{-1})	
1.	*Phragmites communis* Trin. (Reed)	1.17	61.60
4.	*Neptunia prostrata* Lam. (Water mimosa)	5.46	95.90
5.	*Phragmites karka* Retz. (Reed)	1.17	61.60
7.	*Ludwigia adscendens* L. (Francais Khmer Lao)	0.98	64.75
9.	*Polygonum barbatum* L.	0.20	66.15

Phosphorus contents in compost from each type of plants were varied, P were higher in compost of water mimosa (1,675 mg kg^{-1}) and Ludwiginia (1,454 mg kg^{-1}) than in two reeds composts (1160 and 827 mg kg^{-1}) and Polygonum (270 mg kg^{-1}) as shown in Table 4. This contents are very good if compare to Bokasi (556,4 mg kg^{-1}) as reported by Dermiyati *et al.* 2009) but lower than P content in compost of Thitonia (Nurhayati *et al.* 2014). It indicates water mimosa and Ludwiginia can be used as P sources for plant.

K, Ca, Mg and Na nutrients content also differred in each compost, K were higher in water mimosa (5.6%) and Francaes Khmer Lao (5.0%) than in three other composts. In the case of Ca content, results showed Francaes Khmer Lao and Polygonum barbatum contained Ca more than other composts. It showed only water mimosa compost produced rather high Mg (0.32%) and others had less than 0.07%. All composts from those wild plants contained low Na, this is understanble because Na is not as macro nutrient for some plants (Table 4). However, K and Mg content in this composts were higher compared to their content in empty fruit bunches of oil palm where K (0.73 cmol kg^{-1}), Mg (0.15) and Ca (0.14%) as reported by Budianta *et al.* 2010.

Eventhough some of macro nutrients content were not high, if the application of compost for organic rice plantation was 10 ton ha^{-1}, thus compost of water mimosa could supply nutrients at least N (400 kg), P (16.75 kg), K (560 kg), Ca and Mg (32 kg). So this composts can be used for organic farming system such as rice organic or other organic crops.

Fe and Al Contents in Compost

It seems that Fe (from 0.20 to 5.46 ppm) and Al (from 61.60 to 95.90 ppm) contents were not high in compost from varied plants eventhough the plants grow in very acid lowland soils, which usually contains high alumunium and iron (Table 5). The maximum content of Fe in compost is 8000 ppm according to Ministry of Agriculture of Indonesia No. 28/Permentan/SR.130/5/2009. So all the wild plants used in the experiment can be used as safe nutrient resources.

It has been kown that these swamp plants grown in acid or potential sulphate soils where the pH can be under 3.5 (Sagala and Bernas 2008). According to Shamshuddin 2006 *in* Shazana *et al.* 2014 acid sulfate soils containned high amounts of Al and/or Fe and low in pH (3.5). In submerged condition, stable Fe^{3+} would change into soluble Fe^{2+}, which the excess amount of this cation form would harm plant growth (Herviyanti *et al.* 2010). Aluminium taken up by plants tended to accumulate in the roots and was not easily translocated to the shoots and retained in the root cell walls (Clarkson 1967 *in* Rowell 1988), so the plants tolerate in acid soil will contain low Al in shoots and branches, thus can be utilized for compost sources.

CONCLUSIONS

Neptunia prostrata Lam and *Ludwigia adscendens* L. are the best for compost sources because of high content of N, P and K, however *Ludwigia adscendens* L. contained thick liquid making like a wet sticky compost. All composts made of various plants do not contain high Fe and Al, thus can be used for compost sources.

It is suggested to make compost by mixing all the plants to hinder too much water content in some plants which can be compensated by low water content plants for making crumble compost.

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