

Chemical Characteristics of Compost and Humic Acid from Sago Waste (*Metroxylon sago*)

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Abstract: Problem statement: Agriculture waste such as Sago Waste (SW) has a potential to cause pollution either on land or in water. In order to reduce this problem, a study was conducted to investigate the effect of three different treatments on the chemical characteristics of compost and humic acid from SW. **Approach:** The study had three treatments which were: T1: SW (80%) + chicken feed (5%) + chicken dung slurry (5%) + molasses (5%) + urea (5%), T2: SW (80%) + chicken feed (10%) + chicken dung slurry (5%) + molasses (5%) and T3: SW (80%) + chicken feed (10%) + chicken dung slurry (5%) + urea (5%). Composting was done for 60 days in a white polystyrene box with a size of 61.5×49×33.5 cm. The composts were analyzed for pH, total nitrogen, organic carbon, organic matter, ash, Cation Exchange Capacity (CEC), phosphorus and HA using standard procedures. **Results:** All treatments did not reach thermophilic phase. Compost of T2 had high quality (pH, total nitrogen, organic carbon, organic matter, ash, Cation Exchange Capacity (CEC), phosphorus and HA) compared to T1 and T3. The yield of HA of T2 was also significantly higher compared to those of T1 and T3. The compost characteristics of T1 and T3 were similar. The chemical characteristics of HA the 3 treatments were within the standard range reported by other researchers. **Conclusion:** T2 is more efficient in producing mature and good quality compost in 60 days compared to T1 and T3.

Key words: Sago Waste (SW), compost, Humic Acid (HA)

INTRODUCTION

It is estimated that about 60 million tonnes of sago starch, extracted from sago palms, are produced per annum in south-east Asia^[1]. Most of the factories are built near riversides where Sago Waste (SW) is likely to be discarded into rivers, a practice which may cause water pollution. Some researchers have used SW as substrate for cultivation of edible mushrooms^[2], animal feed, production of enzymes^[3] and absorbents^[4]. SW also can be used for composting where the Humic Acids (HAs) can be extracted from the mature compost and can be treated as the backbone of fertilizer.

Humic acids are imported from other countries at a high cost into Malaysia because of cheap source of this acid. The use of humates is being as an organic based fertilizer compared to inorganic fertilizers which have implicated in environmental pollution due to

unbalanced has been a global concern. Humic acids are the main and more stable component of organic matter, hence they contribute to soil fertility and soil health^[5]. Besides that, HA regulates the carbon cycle and the release of nutrients including N, P and S in the soil^[6].

As one of the means of utilizing SW, a study was conducted to investigate the chemical characteristics of HA and compost from SW.

MATERIALS AND METHODS

The SW was collected from Nit Sei in Mukah, Sarawak, Malaysia. The SW was air-dried and used for the compost. Composting was done inside a white polystyrene box with a size of 61.5×49×33.5 cm. The study had the following treatments:

T1: SW (80%)+chicken feed (5%)+chicken dung slurry (5%)+molasses (5%)+urea (5%)

- T2: SW (80%)+chicken feed (10%)+chicken dung slurry (5%)+molasses (5%)
 T3: SW (80%)+chicken feed (10%)+chicken dung slurry (5%)+urea (5%)

The ambient and compost temperatures were taken daily (morning and evening). The temperature of the compost was monitored until it equaled ambient temperature after which it was analyzed for pH, total nitrogen, organic carbon, organic matter, ash, Cation Exchange Capacity (CEC), phosphorus and HA using standard procedures. The moisture content of the compost ranged between 50-70%^[7] and turning was done once a week.

The HA was isolated by the method of Stevenson^[8] but with some modifications. The compost and hydroxide (0.002 M) were placed inside a polyethylene bottle in a ratio of 1:10 (weight: Volume basis). The mixture was shaken at 240 rpm for 24 h at room temperature. Afterwards, the mixture was centrifuged for 15 min at 10,000 rpm. The dark-colored supernatant liquid containing HA was decanted, filtered using Whatman filter paper number 2, pH of the liquid adjusted to 1.0 using 6N HCl and allowed to stand at room temperature for 24 h. The suspension containing HA was transferred into polyethylene bottle and centrifuged at 10,000 rpm for 10 min. The HA was purified by the method of Ahmed *et al.*^[9], by using distilled water and through centrifugation at 10,000 rpm for 10 min to reduce mineral matter and HCl during acidification. After the purification, the HA was oven dried at 40°C until constant weight was attained.

The ash and organic carbon contents of the HA were determined by the dry combustion method^[10]. The functional group analysis was done according to Inbar *et al.*^[11] where 20 mg of HA was dissolved in 4 mL of 0.08 M NaOH and shaken for 30 min at 180 rpm. The solution was titrated with 0.10 M HCl to pH 2.5 (within 15 min). Carboxyl content was calculated based on the amount of acid required to titrate the suspension between pH 8 and the end point (approximately pH 3). Phenol content was calculated by assuming that 50% of the phenols dissociated at pH 10. Total acidity was calculated by summation of the carboxyl and phenols. E₄/E₆ determined by the method of Campitelli and Ceppi^[5] and analyzed using UV-Vis spectrophotometer (Perkin-Elmer Lambda 11).

Analysis of Variance (ANOVA) and General Linear Model (GLM) were used to test the effect of treatments while means of treatments were compared using Tukey's Test. Statistical Analysis System (SAS Ver. 9.2) was used for the statistical analysis.

RESULTS

Figure 1 shows the trend of the temperature of the composted SW with different treatments. The compost temperatures for all the treatments were below thermophilic stage which begins from 45°C and above^[12]. Only T2 reached a temperature more than 40°C and was in the mesophilic phase for eight weeks and gradually decreased to equal ambient temperature (Fig. 1). In addition, the compost of T2 matured in 60 days while those of T1 and T3 were less mature at this period. The temperature of T1 and T3 were in ambient temperature for weeks and gradually increased after 20 days.

The pH, C/N ratio, CEC, ash and organic matter of T1 and T3 were similar but these chemical characteristics were statistical different from that of T2. The C/P ratio of T1 was the highest, followed by T3 and T2 (Table 1).

The chemical characteristics of HA for T1, T2 and T3 of SW compost are shown in Table 2. The E₄/E₆ which indicates humification index was significantly different for all of the treatments. Carbon and ash are related where T1 had the same effect with T2 and T3. The phenolic group was 200 for T1, T2 and T3 respectively. In the case of carboxylic group, that of T3 was not significant different from those of T1 and T2

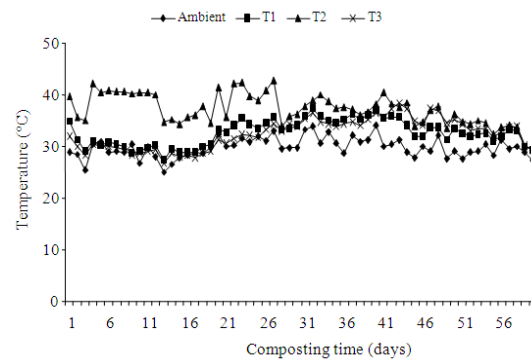


Fig. 1: Compost in different treatments (T1, T2 and T3) and ambient temperature during SW composting

Table 1: Comparison of the chemical characteristics in different treatments (T1, T2 and T3) of SW composting

	T1	T2	T3	Standard range ^[13]
E ₄ /E ₆	8.26 ^a	8.58 ^a	8.43 ^a	7-8
Carbon	55.92 ^{ab}	56.83 ^a	55.11 ^b	56-62
Phenolic	200.00 ^a	200.00 ^a	200.00 ^a	240-540
Carboxylic	250.00 ^b	300.00 ^a	283.00 ^{ab}	150-440
Total acidity	450.00 ^b	500.00 ^a	483.00 ^{ab}	500-700

Different letters indicate significant difference between means using Tukey's Test at p = 0.05

Table 2: Chemical characteristics of HAs extracted from different treatments (T1, T2 and T3) of SW composting

	Initial	T1	T2	T3
pH	4.58	6.86 ^b	7.397 ^a	6.743 ^b
C/N ratio	790.10	44.12 ^a	27.33 ^b	41.43 ^a
C/P ratio	4485.42	249.67 ^a	57.82 ^c	157.103 ^b
CEC (cmol kg ⁻¹)	14.90	119.33 ^b	238.89 ^a	165.33 ^b
Ash (%)	4.53	6.74 ^b	20.93 ^a	8.14 ^b
Organic matter (%)	95.50	93.26 ^a	79.07 ^b	91.86 ^a
Humic acid (%)	0.02	0.55 ^b	1.15 ^a	0.44 ^b

however, the contents of the carboxylic group of T1 and T2 were statistically different. The total acidity of T2 was significantly different from that of T1 but not T3. The chemical characteristics for all treatments were mostly in the standard range^[13].

DISCUSSION

Although T2 did not reach thermophilic stage, its compost matured in 60 days and this may be due to maximum microbial diversity during the mesophilic stage 40-45°C^[14]. The abundance of readily available and easily digestible substrate (e.g., sugars, starches, simple protein compounds) might have ensured that the microorganisms were active. Relatively, low temperature in the compost facilitated the growth and respiration of micro-organisms such as aerobic mould-fungi and bacteria whereas high temperature was due to oxidation of cellulosic materials^[15]. Lignin was degraded slowly in the mesophilic stage perhaps due to increase in fungal activity^[14]. According to Smidt *et al.*^[16], glucose can maintain a certain level of microbial activity which was perhaps from the molasses and SW itself. Cayuela *et al.*^[17] reported that fungi have the ability to produce enzymes that are able to degrade lignin and had attributed to the reduction of easily degradable organic compounds and the subsequent decrease in bacteria^[18]. This may be one of the reasons why the compost did not reach the thermophilic stage.

The presence of urea in T1 and T3 may have probably increased the ammonia emission. Large quantity of nitrogen may limit carbon availability as a source of energy for the microbes. This slowed down the decomposition process of T1 and T3 from day one until day twenty. The loss of N through ammonia release then can be available again when the microorganisms die. This can be shown by the temperature of T1 and T3 which is the indicator of microbial activity^[19]. The temperature of T1 and T3 increased after 20 days (Table 1). In terms of time reduction, T2 is more efficient because its compost

matured in 60 days while those of T1 and T3 needed longer time to reach maturity.

The pH of the composts (T1, T2 and T3) increased from acidic to neutral due to degradation of acid-type compounds like carboxylic and phenolic groups or mineralization of compounds such as protein, amino acids and peptides to ammonia^[20,21]. The C/N and C/P ratios decreased due to mineralization. The decreased in organic matter content was caused by mineralization and humification^[20] resulting in the increase of ash content and HA. High content of ash resulted in high content of minerals which also reflected the increase in Cation Exchange Capacity (CEC). CEC suggests high amount of available minerals in the compost. Available minerals are very essential for plant growth and development. The higher content of HA at the end of the composting period compared to before composting suggests the occurrence of humification and stability of the compost^[22] which had also increased compared to the uncomposted material.

High E₄/E₆ of the regardless of treatment indicates the presence of HA with low molecular weight^[13]. High E₄/E₆ ratio reflects a low degree of aromatic condensation and presence of a relatively large proportion of aliphatic structure indeed^[23,24]. It has also been reported that composts have lower degree of aromatization than soil^[25]. The carbon content of the HA of the composted SW was in the range of the standard values. The values of carboxyl-COOH, phenolic-OH and total acidity of HA of the SW were also consistent those of standard range^[13].

CONCLUSION

T2 is more efficient in producing mature and good quality compost in 60 days compared to T1 and T3.

ACKNOWLEDGEMENT

This study was supported by a Fund of Ministry of Agriculture and Agro-based Industry Malaysia entitled "Utilization of sago waste in animal production". The authors acknowledge the assistance of the staffs of University Putra Malaysia, Bintulu Sarawak Campus, Malaysia.

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