UTILIZATION OF TANNERY WASTES AS SOIL LESS MEDIA IN AGRICULTURE FOR TOMATO GROWTH

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ABSTRACT

Tannery industries create serious environmental problems especially in terms of polluting organic effluent and the hazardous solid wastes as a result of hides and skin processing. Tannery waste is categorized as toxic and hazardous waste in Malaysia due to the high content of Cr (in excess of 500 ppm) and other heavy metals. It is very important that tannery wastes in the form of sludge and shavings are managed in an environmentally sound manner. This study focused on utilization of tannery wastes as soil less media to grow tomatoes. The results showed that there was a significant difference between initial and final sample in term of Electrical Conductivity (EC), pH, root to shoot ratio and plant height. However, % seed germination at 5 days was inhibited and significantly reduced at 14 days from sowing date with 100%, 75% and 50% of both sludge and shaving. The result also indicated that 50% and 25% treatments of both wastes provide more appropriate media for plant growth compared to other treatments.
Keywords: *Tannery sludge, shaving, tomato, germination.*

INTRODUCTION

The leather industry is associated with the generation of huge amount of liquid wastes (30-35 lit/kg of raw material processed) and 150,000 tonnes of dry sludge annually and thus disposal of these wastes become a serious problem. Basically, three types of by products are produced**:** solid wastes from splitting and trimming hides; sludge from liming, dehairing, pickling, and chrome tanning; and liquid wastes from each step in the operation (Hughes, 1988). The primary constraint on utilization of tannery byproducts has been the chromium (Cr) content in the sludge. Currently, most processing plants are recycling the chromium in the wastes before they leave the plant. Chromium has been of concern due to its potential plant toxicity. Trivalent chromium (Cr^{+3}) is present in the sludge but is not toxic to plants and is immobile in the soil system. However, hexavalent chromium (Cr^{+6}) is phytotoxic and mobile. Dewatered tannery sludge has nitrogen content ranging from 2.5-5%. When Cr has been adequately excluded from this sludge, the optimum application rates for this sludge should be based on nitrogen needs of the crops to be grown. The objective of this study, therefore, is to characterize and evaluate the use of tannery wastes as media for plant growth.

MATERIALS AND METHODS

Tannery wastes were collected from the Kenny leather Sdn Bhd in Melaka, Malaysia. The sludge or shaving was mixed with tropical peat at application rates of 0, 25, 50, 75, and 100% (w/w). Germination pots were placed in greenhouse in a complete randomized design (CRD) with five treatments and five replicates at an average daily temperature of 28- 38 ^{o}C, daily overhead irrigation was applied, and the data was analyzed according to SAS program. Initial and final EC and pH (H_2O, 1:9 by wt/vol) of the different media combinations were determined

using EC meter and pH meter, respectively. Total Organic Carbon, C/N ratio, total N, P, K, and Ca were determined according to the European International Substrate Manual (2000) for all samples. Heavy metals were determined using Varian Spectra AA220 Fast Sequential (USEPA, 1998 Method 3051).

RESULTS AND DISCUSSION

The chemical properties of the sludge and shaving (Table 1) showed that it was low in C/N ratio (4.25, 20.04 respectively) and high in total nitrogen content especially shaving (11.44) and sludge (0.999). The results were in line with previous work done by Reddy et al., (1977).

Table 1. *Chemical Composition of the tannery wastes used in experiments.*

Parameter	Shavings (Sh)	Sludge (S)	Control	Typical soil *
Organic –C, %	48.67	20.03	32.46	3.9
Nitrogen (N), %	11.44	0.9996	0.41	0.4
C/N	4.25	20.04	79.13	9.75
Potassium, %	0.41	0.415	0.224	0.4 -3
Phosphorus, %	0.002	0.097	0.07	0.05-0.2
Magnesium (mg/l)	788	1190	5450	0.06-6
Iron (mg/l)	68	1062	684	0.7-55
Sodium (mg/l)	1207	1006	-	0.04-3
Chromium	586	1404	-	100
Lead	1	93	-	15
Cadmium	0.83	3.23	-	0.5
Copper	18	41.4	20	20
Zinc	4.67	44.67	2	50
Manganese	8	70	14	850

Mokhtaruddin et.al, 2001.

Table 2. *Electrical Conductivity and pH of each treatment.*

Treatment	EC in dS m $^{-1}$		pH	
Sludge	Initial	Final	Initial	Final
100%S, 0%P	(A) 8.56**	(A) 3.51**	(A)7.36**	(A) 7.85**
75%S, 25%P	(B) 6.37 **	(B) 2.35**	(B)7.29 **	(B)7.44**
50%S, 50%P	(C) 5.85 **	(C) 1.27**	(C) 7.31**	(C)7.77**
25%S, 75%P	(D)4.15 **	(D) 0.85**	(D) 7.18**	(D) 7.37**
100%P (Control)	(E) 0.49 **	(E) 0.03 **	(E) 5.35**	(E) 5.79**
Shaving	Initial	Final	Initial	Final
100%Sh, 0%P	(F)3.16 **	(F) 1.08**	(F) 5.23**	(F) 5.63**
75%Sh, 25%P	(G) 2.11 **	(G) 0.98**	(G) 6.55**	(G) 6.89**
50%Sh, 50%P	(H)1.13 **	(H) 0.86**	(H)6.04**	(H) 6.41**
25%Sh, 75%P	(I) 0.92 **	(I) 0.07**	(I) 5.74 **	(I) 6.83**
R -square	0.99	0.99	0.99	0.99
C.V.	0.281	0.818	0.155	0.358
F	<0.0001	<0.0001	<0.0001	<0.0001
Average Mean	3.637	1.22	6.45	6.89

The means with the same letter are not significant with Duncan's multiple range tests at 0.05
Comparisons significant level at 0.05 levels are indicated by.

The P content of the sludge was 0.097% while that of shaving was 0.002%. The K content of the sludge and shaving was the same about 0.41%. Sommers (1977) proved that, the K level in sludge are usually low and can range from 0.02 to 2.6 % but is enough for plant uptake and is still sufficient for crop requirement. Apart from the plant nutrient, the waste contain high amount of Cr, Ca, Na, and Pb, the whole have negative impact on plant growth . The level of Cr was very high ,which was above the typical level in the soil (100 mg/l) .The Pb content is high in sludge (93 mg/l) but low in shavings (1 mg/l); the typical level of Pb content in the soil is 15 mg/l (Chaney and Ryan, 1993; Chaney, 1990). So from the above results it seems that the tannery wastes were on the acceptable concentration level except for Cr, which was above typical level. Initial electric conductivity (EC) and pH (H_2O 1:9) of the different media combinations before and after treatment shows that there was significant difference within the treatments in term of EC and pH as shown in Table 2. The pH of the sludge was higher (average 7.5), while that of shaving was slightly acidic (average 6.1,) this high pH was due to addition of lime in the removal of hair during tannery process.

Average plant height, leaf area and root to shoot ratio after 6 weeks of sowing date were varied in response to waste combination (Table 3).

Table 3. *Average plant height, leaf area, and root to shoot ratio of tomato growth.*

Treatments	Plant height (cm)	Leaf area $(cm)^2$	Root Shoot Ratio
		Sludge	
100%S, 0%P	(A) 0¨	(A) 0¨	(A) 0
75%S, 25%P	(B) 2.5¨	(B) 7.3¨	(B) 0.3
50%S, 50%P	(C) 47.7¨	(C)26.5¨	(C) 0.7¨
25%S ,75%P	(D) 27.5¨	(D) 25¨	(D) 0.5¨
Contro l (100%P)	(E) 20.9¨	(E) 24.8	(B) 0.2¨
		Shaving	
100%Sh, 0%P	(F) 4.9¨	(F) 1.6¨	(D) 0.5
75%Sh, 25%P	(F) 4.7¨	(G)3.9¨	(B) 0.4
50%Sh, 50%P	(G) 7.7¨	(H) 9.8¨	(B) 0.4¨
25%Sh, 75%P	(H) 8.8¨	(I) 16.1¨	(B) 0.5¨
R-square	0.99	0.99	0.86
C.V.	1.229	0.88	24.243
Average Mean	13.82	10.027	0.388
F	<0.0001	<0.0001	<0.0001

The means with same letter was not significant with Duncan's multiple range tests at level 0.05. Comparisons significant level at 0.05 levels are indicated with.

a- Shaving (Sh) ***b- Sludge (S)***

Figure 1. *Effect of Shaving and Sludge as transplant media on production of organic tomato seedling 6 weeks old: a-(100, 75, 50, 25, 0 % Sh) b- (100, 75, 50, 25 and 0%S)*

However, 50% sludge gave the highest stem length, leaf area and root shoot ratio followed by 25% sludge compared to the control, whereas 100% and 75% sludge decreased with no significant difference between them (Table 3). This indicates that the sludge is rich in available macro and micronutrients and thus has the potential to be used in potted media for the production. For shavings, they gave poor plant height, leaf area, and root shoot ratio compared to the control, this might be due to the lower nutrient content in the shaving or, to the high soluble salts which affected the germination and subsequently the shoot length, leaf area and root to shoot ratio .

CONCLUSIONS

The study concludes that treatment using 25% and 50% sludge provide better media for plant growth compared to other treatments (100% and 75%). It also showed that there was a significant difference between initial and final sample in term of EC, pH, root to shoot ratio, plant height, and leaf area. However, percent seed germination at 5 days was inhibited and significantly reduced at 14 days from the sowing date using 100%, 75% and 50% of both sludge and shaving.

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