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COMPOSTING OF SEASTAR (*ASTERIAS AMURENSIS*) WASTES

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BACKGROUND/INTRODUCTION

The presently described work was initiated in July 1993 following funding from the FRDC to assess the feasibility of composting starfish wastes, given the likelihood that significant quantities of seastars may be trapped and returned to shore in the near future. Since bulk material such as this constitutes a noxious environmental waste, it is desirable to have the proven capacity to eliminate it in an acceptable way, preferably with the potential to recycle resultant nutrients to the soil.

An anecdotal report of disposal practice in Japan has it that seastars are dumped in a pit and covered for about a year before the decomposed remnants are used as organic mulch. Such anaerobic degradation is not ideal from an environmental perspective, inevitably resulting in the production of acidic and malodorous by-products relative to aerobic composting. Degradation under aerobic conditions is also more rapid than anaerobic decay.

The objectives of the study were as follows:

(i) To determine the optimal composting conditions for the starfish waste.

(ii) To determine the effect of composting on the saponin toxin present in the starfish.

(iii) To determine levels of faecal coliforms and heavy metals following composting.

(iv) To assess the nutrient value and electrical conductivity (salinity) of the resultant compost.

(v) To demonstrate the effect of the resultant compost on the growth of two plants (lettuces and radishes) in a glasshouse trial.

RESULTS

(i) Determination of optimal composting conditions

Seastars were collected in the Derwent Estuary in the vicinity of the Hobart Docks. The initial collection (used at Roadways Pty Ltd) was provided by courtesy of local diving clubs, while material used at the Tas Crays Pty site was obtained by a contracted diver.

Compost mixes were prepared at Roadway Pty on the 14th July, 1993 of woodwaste:starfish waste in a ratio of 4:1 (by volume) respectively, and at the Tas Crays/Hazell Bros. site on the 23rd August, 1993 of bark waste:starfish waste in ratios of 3:1 and 5:1 (by volume) respectively. The woodwaste material provided by Roadways Pty was of a finer consistency than the bark waste provided by Tas Crays Pty for the other two mixes. All heaps were 1m - 1.5m height at their peak, sufficient to maintain elevated compost temperatures. Heaps were maintained in a moist condition, with water amendment as necessary and with turning by front-end loader at approximately 10d intervals.

Following construction, temperatures of the 4:1 woodwaste:bark mix achieved 50° 2 weeks following construction, with a subsequent decline to 45°, at 4 weeks and to 40° at 7 weeks.

Composting was observed to be rapid, being effectively completed by 7 weeks. At this stage the compost had a good dark consistency, odour was minimal and only a gritty remnant of the starfish remained. The volume of the mix had reduced by more than half at the end of the composting period.

Similar results were obtained for the bark/seastar mixes, but with larger quantities of seastar waste being available (1.3 tonnes per heap, cf less than 1 tonne for the woodwaste mix). Because of the coarser nature of the bark material, the homogeneity of the end product after 2 months composting was not as good as that of the woodwaste mix. At 1 month into the composting, temperatures within the 3:1 mix was 40 - 50° and in the 5:1 mix, 35°. After 2 months the texture of the 3:1 compost was much better than that of the 5:1 mix, with more uncomposted fibrous bark present in the latter. Clearly insufficient NPK-nutrients were available in the 5:1 mix to permit complete composting.

Conclusion: Mixes of woodwaste (primarily sawdust waste) with seastar waste in a ratio of 4:1 (by volume) respectively, or of eucalypt bark:seastar waste of 3:1 (by volume) respectively resulted in a non odorous, excellent consistency compost within 2 months. The 5:1 (by volume) bark:seastar composition was sub-optimal in that a significant proportion of the bark remained uncomposted after 2 months.

(ii) Determination of residual toxicity

The seastar toxins have been shown to be lethal to earthworms, with death occurring in as little as 15 minutes exposure to extracted toxin (Yasumoto et al. Physiological activities of starfish saponin. Bull. Japanese Soc. of Scientific Fisheries 30, 357-364, 1964). In view of the intended end use of the compost, earthworms were considered to be ideal test organisms for assessment of residual toxins. For this test composted material (from the 3:1 and 4:1 mix ratios) was collected after the 2 month period, distributed into containers (200g moist compost in 4 replicates/mix) and amended with *Lumbricus rubellis* (approximately 50 worms/container). As a control, 4 replicates of a commercial woodwaste compost mix was similarly amended. Incubation was at 20 - 25°.

No toxic effect was apparent in any mix over a 2 week period after which the trial was terminated. Since the compost was the only source of nutrition for the earthworms, it was concluded that no residual toxicity was present following 2 months composting under the conditions described.

(iii) Determination of faecal coliforms

To determine the abundance of faecal coliforms, dilutions of the 3:1 seastar:bark waste was cultured on membrane lauryl sulphate agar followed by enrichment of presumptive coliform colonies in lauryl tryptose broth. Acid and gas production in the latter at 44° after 24h verifies identification as a faecal coliform. (The Bacteriological Examination of Drinking Water Supplies, 1982. HMSO, London).

Faecal coliform numbers were determined to be in the order of 4×10^3 cells/g compost material. This is well below requirements for sewage application to land, of 2×10^6 cells/g (Guidelines for the use of sewage sludge on agricultural land. N.S.W. Agriculture, 1991). Pathogen numbers would be further reduced by larger compost heaps, and the resultant higher temperatures.

(iv) Heavy metal content, nutrient value and electrical conductivity of the compost

The 3:1 bark:seastar mix (as above) was assessed by the DPIF Services at Kings Meadows. Results are given below against relevant data from other sources.

The original report from the DPIF is appended.

Conclusions:

1. The seastar compost would not be suitable as material for potting mix compositions (Table 1) even given that the organic matter component is diluted in potting mixes by an equal volume of coarse sand. The electrical conductivity would be a little high, but levels of zinc, boron, iron, magnesium and sodium would be excessively high.

2. The comparison of nutrient contents of seastar compost, dairy manure and sewage sludge (Table 2) is informative, the latter materials being established sources of organic nutrients for land application. Nitrogen content of the seastar compost was less than half that of dairy or sewage wastes (this might be expected given the nil contribution from bark); as was P in comparison to dairy waste (but very much lower than that of sewage sludge). Sodium, calcium and magnesium levels were significantly higher in the compost than either of the other materials. (The elevated sodium represents a higher salinity while high calcium levels would originate from the exoskeleton of the seastar). Potassium levels in the compost were comparable with sewage sludge levels, but 1/10 that of dairy wastes.

3. The seastar compost mix would be well suited to use as an organic mulch for application to agricultural soils (Table 3). Hence it would be in the same category as the fish/bark waste presently marketed by Tas Crays Pty Ltd. Levels of all heavy metals tested were well below those in sewage sludge permitted for such use.

(v) Demonstration of the effect of the compost on the growth of lettuces and tomatoes

The 3:1 bark:seastar compost was converted to a potting mix composition as follows:-

Compost	60% (by volume)
Peat	10% (by volume)
Sand	30% (by volume)
PLUS	
"limil"	2g/L
"dolomite"	5g/L

Seedlings of lettuces and tomatoes (4 replicates of each) were planted in this mix contained in 12 pots and in a standard commercial potting mix (4 replicates) as a control. Incubation was under glasshouse conditions for 6 weeks. Growth of plants in the two formulations was not significantly different after this period.

Conclusion: Despite the material being unsuitable for sale as a potting mix constituent, it performed well relative to a commercial mix in plant growth trials. Tas Crays Pty Ltd presently produce a similar product (for use as a mulch, but not as a potting mix component) from fish waste composted with bark. Data from the N.S.W. Guidelines indicate the seastar compost would be very suitable for retail as a mulch of good nutrient and water holding (a property of the bark component) status.

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<u>TABLE 1. CHARACTERISTICS OF SEASTAR COMPOST (3:1 BARK:SEASTAR) IN RELATION TO POTTING MIX REQUIREMENTS</u>

	Properties of Seastar Compost	Requirements for Potting Mix (regular grade)[a]
Electrical conductivity ds/m	2.65	$\leq$ 2.2
pH	7.1	5.3 - 6.5
Zn (mg/L)	80	0.3 - 10
Boron (mg/L)	10.3	0.02 - 0.65
Iron (mg/L)	6523	$\geq$ 25
Mg (mg/L)	4590	$\geq$ 15
Na (mg/L)	6640	$\leq$ 100
Sulphur (mg/L)	2760	no requirement

[a] From Table 2.1, Australian Standard for Potting Mixes, A.S., 3743 - 1993.

TABLE 2. NUTRIENT CONTENT OF SEASTAR COMPOST (3:1 BARK:SEASTAR) COMPARED WITH DAIRY MANURE AND SEWAGE SLUDGE

	Seastar Compost	Dairy Manure [a]	Sewage Sludge [a]
Total N%	1.56	3.75	3.87
Total P%	0.35	0.8	2.97
Na%	0.66	0.43	0.17
K%	0.24	2.4	0.17
Ca%	3.9	1.3	1.9
Mg%	0.46	0.32	0.37
pH	7.1	7	7.3

[a] Data from Appendix 1, Guidelines for the use of sewage sludge on agricultural land. N.S.W. Agriculture, 1991.

TABLE 3. HEAVY METAL CONTENT OF SEASTAR COMPOST (3:1 BARK:SEASTAR), RELATED TO MAXIMUM LEVELS PERMITTED IN SEWAGE SLUDGE FOR APPLICATION TO AGRICULTURAL LAND

Element	Seastar Compost Content (mg/kg)	Maxmimum permitted Sludge Concentration[a]
Cadmium	0.7	8
Chromium	83	500
Copper	20	1200
Lead	10.4	300
Nickel	9.8	100
Zinc	80	1800

(a) Data from Table 6, Guidelines for the use of sewage sludge on agricultural land.

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STARFISH/WOODWASTE SAMPLE FOR ANALYSIS

Lab No	Total N %	Cd (ppm)	Ni (ppm)	Pb (ppm)	Cr (ppm)	Dm %	pH	M/S
46256	1.56	0.7	9.8	10.4	82.9	54.5	7.1	2.65

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STARFISH/WOODWASTE

LAB NO.	MARKS	P %	K %	ZN PPM	B PPM	FE PPM	CA %	MG %	NA %	S %	MN PPM	CU PPM
46256	1	0.346	0.238	80.1	10.3	6523	3.92	0.459	0.664	0.276	129	19.8