



Composting sludges generated within tannery effluent treatment and other solid waste from leather manufacture

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Mechanical turning of the 15 tons of compost produced each day from the tannery for aeration as part of the biological process.

The composting of tannery sludge generated from full effluent treatment of wastewaters from vegetable and chrome tanning processes was investigated. On the basis of these studies all of the sludge from the effluent treatment plant and other organic waste from a tannery are now being composted on site on a full industrial scale.

The investigation

The main material used in this project was the sludge from the effluent treatment plant of Sepiciler Caybasi Tannery, Turkey. This effluent consists of the wastewaters from both chrome tanning and vegetable tanning, at a production ratio of 50:50.

The effluent treatment comprises conventional screening, aeration, chemical dosing and clarification for primary treatment. Secondary treatment includes biological treatment using the activated sludge treatment method and secondary clarification. The sludges generated are dewatered using a belt press sludge dewatering system, producing a sludge of approximately 25% solids content, 75% water.

The study was performed in two major steps.

- 1] Small scale investigations
- 2] Field scale investigations

These investigations formed the basis for the composting of all

tannery sludges, together with all fleshings after grease removal, and vegetable tanned wastes produced by Sepiciler Caybasi Leather Ind. Inc.

1] The initial small scale investigations

The first step was conducted on a pilot scale to define the sludge's suitability for composting. The various raw materials used included:

- The sludge from primary and secondary effluent treatment following belt pressing.
- Vegetable tanned leather shavings and dust generated from the vegetable tanning section of the tannery.
- Protein waste from limed fleshings. At the time of the investigation a full scale operation was already established where all of the limed fleshings were cooked to extract the natural grease, and the residual fleshings then dewatered by centrifuge.
- Tobacco leaf waste supplied from a nearby facility.



The composition of each of these raw materials is given in *Panel 1*:

Panel 1: Composition of the individual raw materials

Analysis	Raw material description			
	Tannery sludge	Vegetable tanned shavings	Solid protein after treating fleshings	Tobacco leaf waste
Moisture content %	73	54	57	12
Organic matter %	96	87	76	53
Total organic carbon ppm	8220	31778	119200	160000
Total nitrogen ppm	1370	4546	4900	6000

Four different mixtures were prepared from these raw materials, and the content within each mix is presented in *Panel 2*:

Panel 2: Composition of the initial composting mixtures

Mix	% components in the compost blends				
	Tannery sludge	Vegetable tanned shavings	Solid protein after treating fleshings	Tobacco leaf waste	Total
1	60	40	0	0	100
2	60	20	10	10	100
3	50	10	20	20	100
4	60	25	5	20	100

The major raw material in each of the mixtures is tannery sludge. Vegetable leather shavings were used to gain porosity and texture in the mixture and for the bacterial community as it evolved. Tobacco leaves and protein from fleshings were included to amend the C/N ratio and provide fresh bacterial population to start the aerobic decomposition. The fleshings also provided triglycerides that control the occurrence and loss of ammonia.

In preparation for the composting process, the moisture content of each of the four mixtures was adjusted to 75%. An analysis of these moisture amended mixtures is set down as *Panel 3*:

Panel 3: Analysis of the four moisture amended mixtures before composting

Mix	Properties of the mixed components				
	Moisture Content %*	Organic Matter (% d.m)	Total Organic Carbon ppm	Total Nitrogen ppm	C:N ratio
1	75	92.4	17643	2640	7:1
2	75	67.4	39208	2821	14:1
3	75	82.4	63128	3320	19:1
4	75	82.8	50837	3404	15:1

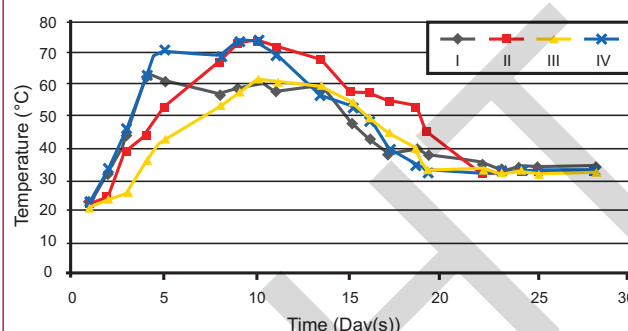
The blended solids were formed into piles at a height of 0.75m and width 1.2m. Aeration was obtained by manually turning and mixing the piles, and the trials were conducted for a 28-day period. The initial water content in each mixture of 75% was not allowed to fall below 45% in the first 20 days. The temperature profile of the composting piles over the period of 28-days is given in *Panel 4*.

This shows that the pile temperatures instantly raised and exceeded the pasteurisation threshold of 60°C in the first week of the study, with the exception of Mix III.

It is important to emphasise:

- The temperatures within each pile decreased with the drop in water content. For this reason, the moisture content was kept under close control during the first 20-days of composting.

Panel 4: The temperature profiles within pilot-scale composting piles



- There were two important factors that affected the composting period: the C/N ratio that was available, and a sufficient initial microbial consortium.

The initial C/N ratio in Mix I was lower than Mix III, and the higher microbial population that developed in Mix I resulted in an early completion of the composting process, even though the water content was kept around 60%. Mix III has a better C/N ratio than the other mixes, but the higher tobacco leaf ratio did not lead to a suitable microbial consortium. For this reason the temperature rise was slower than Mix I and relatively low temperatures were observed.

Better temperature profiles were seen in Mix II and Mix IV where the positive effects of protein waste and tobacco leaf waste are apparent. It was also concluded that in these two blends the microbial consortia supplied by vegetable waste was sufficient.

However, the temperate profile of Mix II is preferred for efficient TOC stabilisation. The final C/N ratio and the moisture content of the products on completion of the composting process are given in *Panel 5*:

Panel 5: Properties of the final product from initial composting studies

Mixture	Moisture content%*	C:N ratio
1	43	7:1
2	27	19:1
3	34	16:1
4	29	11:1

The findings from these pilot-scale studies formed the base for field scale investigations.

2) Field scale investigations

In this second phase of the investigation, the height of the pile (the windrow) was 1.5m and the width 2.7m with a trapezoidal cross section, with approximately 10 tons of waste mixture for composting.

As the best results were achieved in the initial investigation with mixtures containing the higher levels of tannery sludge, the ratio of tannery sludge in this second phase of investigations was increased. The sludge content was amended to 80%, the tobacco leaf waste to 10%, vegetable shavings to 8% and the protein waste 2%. This recipe was also suited to the waste generated from the tannery.

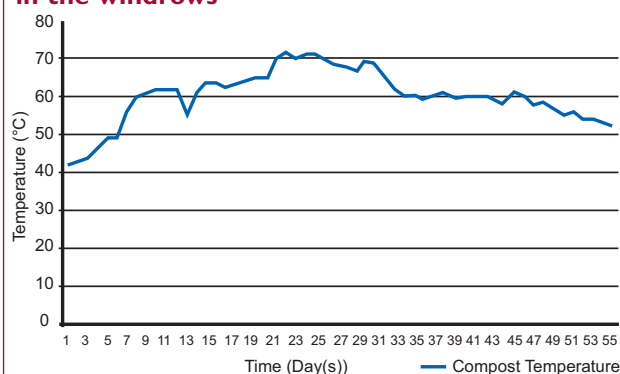
The windrows were mixed manually in the initial stages of



these trials, but then a tractor operated compost blending machine was obtained and employed. The temperature within the windrows during the composting process and the moisture content were also followed, and the final product properties were analysed at the end of the process.

A significant increase in temperature was observed and the profile and variation is shown in *Panel 6*:

Panel 6: Temperature profile and variation in the windrows



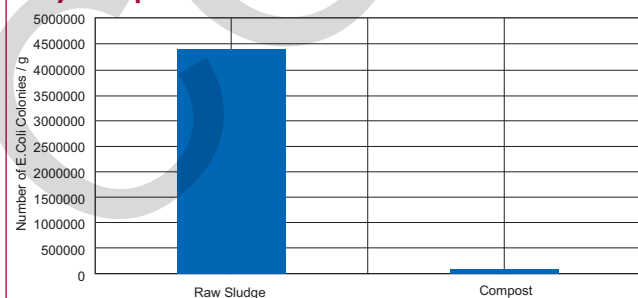
This shows that the temperature increased to 72°C, ensuring full conversion of the raw materials into useable compost. It was also found best to keep the windrow temperature over 50°C for 58 days of composting. This was managed by systematic aeration using the compost blending machine together with wetting to maintain the moisture content at optimum level.

It is known that a pasteurisation of pathogens occurs in composting. This is not just due to sterilisation effects due to high temperatures, but because of the development of bacteria that release antibiotics. The presence of actinomycetes was also observed at the crown of the windrows when a section was opened once aeration ceased in the last stage of composting.

The presence of *Escherichia Coli* in the raw sludge and in the composted material was also analysed within this investigation. The colony count in raw sludge and compost was $44 \times 10^5 \pm 21 \times 10^4$ (number of colonies / g) and $60 \times 10^3 \pm 25 \times 10^3$ respectively.

These results showed that the 99% *E.coli* reduction was achieved during composting. The graphical presentation of *E. coli* stabilisation is presented as *Panel 7*.

Panel 7: E. coli population in raw sludge and fully composted material



The mass reduction during composting process was also measured and found to be approximately 53%. It can be concluded that tannery sludge can be successfully composted with other wastes produced in the facility.

The heavy metals in the final product were also analysed and the results found below the EU 86/278/EEC Directive (European Commission, 1986) Limit Values, as shown in *Panel 8*:

Panel 8: Heavy metal concentrations in compost and EU Regulatory Limits

Metals	Metal concentrations in compost (Mg/Kg dry weight)	278 EEC Directive Limit Values (Mg/Kg dry weight)
Cadmium	0.9	20-40
Copper	31	1000 - 1750
Nickle	27	300 - 400
Lead	19	750 - 1200
Zinc	99	2500 - 4000
Mercury	0	16-25
Chromium	6270	-

In addition, nutrients and other properties were analysed and the findings are given in *Panel 9*.

Panel 9: Properties of the compost

Parameter	Value
Nitrogen %	35500
Phosphorous %	2680
Potassium %	3500
!A	8.0
Electrical conductivity dS/m	32.6
Organic matter (% on dry weight)	43
Water content %	20

Trials are taking place to assess the value of this compost within plant growth, and to blend this compost with other sources and soil conditioning agents to reduce the overall chromium content to, say, 1000 mg/l. In addition, investigations are taking place within the tannery to improve the efficiency of the chrome tannage and thus reduce the levels of chromium within sludges generated from effluent treatment.

Conclusions from the investigation

The findings from the investigation can be summarised as follows:

- Tannery sludge from comprehensive effluent treatment can be composted.
- Other tannery wastes such as degreased fleshings, vegetable tanned shavings and dust can be included as co-products.
- The tannery sludge ratio in the waste mixes can be as high as 80%.
- The presence of sufficient aerobic bacterial consortia in the initial raw components within the blend is prerequisite for successful composting.
- The initial C/N ratio is important to sustain and complete the composting process.
- Bacterial pasteurisation can be achieved.
- The nutrient levels in the final product are satisfactory. ☺

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