Evaluating Sustainable Use and Management of Winery Solid Wastes through Composting

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Most solid waste produced by South African wineries during wine making processes includes wine filter wastes derived from perlite and Diatomaceous earth. Wine filter wastes together with grapevine pruning canes, berry skins, seeds and stalks can be used to make compost as a waste minimization and management strategy for the wine industry. The objective of the study was to investigate the feasibility of using winery solid waste and grape products on composting. Wine filter wastes together with grapevine pruning canes and berry skins, seeds and stalks were successfully used to make compost of good quality. Compost piles that had between 40% to 50% of wine filter wastes resulted in successful composting. Turning of compost heaps increased temperatures, which was a positive factor during composting. Furthermore, some compost parameters are likely to change from season to season as composting weather conditions, quantities and probably also chemical composition of wine filter wastes generated seasonally may vary.

INTRODUCTION

Increased wine production has resulted in wineries generating large volumes of wastes and this puts pressure on natural resources (Mulidzi *et al.,* 2016). Most solid waste produced by South African wineries during wine making processes include filter wastes and clarifying that were derived from perlite and Diatomaceous earth (Mulidzi *et al.,* 2018). This waste cannot be disposed in the environment without following legislation as the leachate may contain residues that are harmful (Mulidzi, 2021). There are wineries that still dispose of waste on their own land (Zingelwa-Masekwana, 2012). In addition, some wineries dump solid wastes in rented dumping sites and municipal landfills (Masowa *et al.,* 2015).

Currently, there are increasing limits about the use of landfills and global environmental related pressures for industries to manage waste in a more sustainable way (Mulidzi, 2001). In a study done at different South African wineries, it was observed that most of the difficult waste to treat during wine making processes was generated through the use of filter powders such as Diatomaceous earth and perlite (Zingelwa-Masekwana, 2012). Most wineries prefer that bentonite lees and used filtration material be sent to commercial recycling companies for the recovery of alcohol and tartaric acid to prevent the leaching of the alcohol and acid, which can pollute the environment (Theron, 2013). Wineries are obliged to comply with government legislations regarding waste disposal and management (Mulidzi *et al*., 2015). Lack of proper management of solid wastes could lead to serious environmental pollution for the wine industry hence alternative waste minimization and management strategies need to be investigated (Mulidzi, *et al.,* 2016). Recycling of wastes through composting is generally used as a management strategy of organic waste (Arvanitoyannis *et al.,* 2006). Recycling of waste is regarded as most effective waste treatment adopted worldwide (Mtimkulu, *et al.,* 2016). Bertran *et al.,* (2004), define composting as decomposition of organic wastes and biological control under conditions that allow development of thermophilic temperatures. The process is used worldwide as a treatment for solid organic waste (Masowa *et al*., 2018). After composting, the final product normally has a smaller volume and mass than the initial material and may have a high agronomic value (Bonthuys, 2016).

The objectives of the study were three-fold, namely to (i) determine the effects of using varying amounts of wine filter waste materials, together with other grape and vineyard materials on compost characteristics, (ii) determine the effects of turning and not turning compost heaps on compost characteristics and (iii) determine the effects of lining and not lining compost heaps on compost characteristics.

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MATERIALS AND METHODS

Treatments

The study was conducted at the Agricultural Research Council Nietvoorbij farm in Stellenbosch, South Africa over three consecutive vintage years, i.e. 2012/13, 2013/14 and 2014/15. Thirty six compost heaps (≈3m^3) were laid out following a randomised block design. Details of the treatments are described in Table 1 as follows: T0 where no winery filter waste {0%Winery Filter Waste (WFW)}= [0% Winery Filter Waste perlite derived (FWp)+ Diatomaceous earth derived (de) + 67% Pruning Canes (PC) + 8% Berry stalks (BS) + 25% Berry skins and seeds (BSS)]; T1(≈40%WFW)= [32% WFWp + 8% WFWde + 40%PC + 5% BS + 15% BSS) and T2(≈50%WFW)= [42% WFWp + 8% WFWde + 40% PC, 5% BS + 5% BSS)]. The subplot factors were: (a) turning and (b) lining treatments of the compost heaps. The turning treatment was divided into (i) No-turn, which involved compost heaps that were not turned (ii) Turn, which involved compost heaps that were turned once a week. The lining treatment was divided into (i) No-lining, which involved compost heaps that were laid out on bare hardened soil surfaces and (ii) Lining, which involved compost heaps that were laid out on surfaces lined with a 1 mm dam plastic liner. Temperatures were measured on a weekly basis using a 1 m long temperature probe during different composting stages. Compost heaps were harvested and sampled after approximately 5 (2012/13), exactly 5 (2013/14) and 4 months (2014/15) and thereafter analysed for selected chemical parameters such as (pH, Potassium, Sodium, Phosphorus and others). Data was analysed separately per season and combined, making it possible to observe the effects of using WFW from different seasons on the composting process and the composition of the final composts.

RESULTS

Effects of using varying amounts of winery wastes on compost characteristics

Temperatures

Temperatures seemed to decrease with composting stages and T1 attained mean temperatures that were significantly higher by 4˚C and 2˚C during composting stages 60 and 120 days, respectively than those of T2 (Table 2). During the rest of the stages, T1 and T2 exhibited similar temperatures and both reached their highest temperatures during the initial composting stage (Table 2). Therefore, T1 reached higher mean temperatures than T2, in the beginning (29˚C vs. 25˚C) and towards the end stages (24˚C vs. 22 ˚C) of composting. Furthermore, with all three years of temperature data combined, T1 and T2 attained average temperatures of 24.90˚C and 23.93˚C, respectively during an approximately 135-day composting period (data not shown).

TABLE 1
Percentage (%) allocations of winery and vineyard waste materials making up various treatments for the 2012/13 to 2014/15 compost production periods.

Main treatments (% Wine filter wastes)	Wine filter wastes (WFW) %		Pruning canes (%)	Berry stalks (%)	Berry skins and seeds (%)
	Perlite-derived (p)	Diatomaceous earth-derived (de)**			
T0 (0%WFWp*+de)	0	0	67	8	25
T1 (≈40%WFWp+de)	32	8	40	5	15
T2 (≈50%WFWp+de)	42	8	40	5	5

*Winery filter waste perlite derived (WFWp)
**Diatomaceous earth derived (de)

TABLE 2
Mean temperatures of various winery solid waste composts during different composting stages of the 2012/13 to 2014/15 compost production periods.

Composting stages	Temperature (˚C) of main-treatments		
(days)	T0[1]	T1[1]	T2[1]
60	21.74hij[2]	29.13a	25.30cd
75	21.33j	25.74bc	25.88b
90	22.10hi	24.72ef	24.82de
105	21.27j	24.25fg	23.91g
120	21.50j	23.88g	22.17h
135	20.45k	21.65ij	21.51j

(1)Refer to Table 1
(2)Different letters within the same rows and columns denote significant differences (P=0.05)

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Chemical and physical parameters

Chemical and physical parameters of final winery solid waste composts produced over three production seasons (2012/13 to 2014/15) and commercial composts (CC2 & CC3) are indicated in Table 3.

pH: Overall, pH values increased significantly with the use of wine filter wastes, shifting them from acidic (T0) to basic (T1 and T2) while T2 obtained higher values than T1. The pH values of both T1 and T2 were comparable to those of CC2 (Table 3).

Macro-elements: Nitrogen, P and Na contents increased significantly with the use of wine filter wastes and were similar in both T1 and T2 (Table 3). Furthermore, K contents increased significantly with the use of wine filter wastes and T2 had higher levels than T1. In contrast, C contents, C/N ratios, Ca as well as Mg contents decreased significantly with the use of wine filter wastes (Table 3). The C contents, C/N ratios were similar for both T1 and T2, regardless of the differences in wine filter wastes. However, T2 was found with lower Ca and Mg contents than T1 (Table 3). Nitrogen, K, Ca and Mg contents as well as Na concentrations of T1 and T2 were above those of both commercial composts (Table 3). The P levels of both T1 and T2 were below and above those of CC2 and CC3, respectively. However, C contents of both T1 and T2 were comparable to those of both commercial composts.

Micro-elements: Concentrations of B and Fe increased significantly with the use of wine filter wastes (Table 3). Concentrations of B were similar in both T1 and T2, while those of Fe were higher for T2 than T1. Concentrations of Cu, Mn and Zn decreased significantly with the use of wine filter wastes (Table 3). Concentrations of Cu and Mn were similar for both T1 and T2, while those of Zn were lower for T2 than T1. Concentrations of B and Fe for T1 and T2 were above those of commercial composts, but, those of Cu for T1 and T2, could be considered comparable to those CC2, while those of Mn and Zn to those of CC3.

Physical parameters: Moisture contents increased significantly with the use of wine filter wastes where T1 was used, while decreasing with regards to T2 (Table 3). Therefore, overall T2 contained a lower moisture content than T1. Density values and ash contents increased significantly with the use of wine filter wastes, but T1 was found with higher and lower, density values and ash contents, respectively than T2. Overall, the three compost production seasons, regardless of the differences in the amounts of wine filter wastes used, T1

TABLE 3
Chemical and physical parameters of winery solid waste composts produced over three seasons (2012/13-2014/15) and commercial composts bought for comparison.

Characteristics	Main treatments[(1)]			Commercial composts	
	T0	T1	T2	CC2	CC3
pH	6,52c[(2)]	8,75b	9,27a	8.2	5.7
Resistance(Ohm)	185a	67b	62c	-	-
C(%)	21,25a	16,33b	16,07b	19.40	19.92
N(%)	1,86b	2,18a	2,11a	1.33	0.73
C/N	11a	8b	8b	15	27
P(%)	0,11b	0,26a	0,26a	0.53	0.12
K(%)	0,91c	3,50b	4,25a	0.0034	0.0009
Ca(%)	0,86a	0,57b	0,50c	0.0037	0.0023
Mg(%)	0,23a	0,11b	0,09c	0.0017	0.0006
Na(mg/kg)	935b	3659a	3757a	10.3	2.48
B(mg/kg)	31,15b	45,83a	47,17a	10.96	3.95
Fe(mg/kg)	6241c	7667b	8312a	485	463
Cu(mg/kg)	21,59a	16,48b	16,83b	9.61	4.27
Mn(mg/kg)	52,59a	46,09b	44,95b	197.39	66.50
Zn(mg/kg)	48,79a	32,19b	27,71c	145.67	34.27
Moisture(%)	63,78b	64,97a	62,64c	-	-
Density(kg/m^3)	682c	857a	822b	-	-
Ash(%)	29,14c	55,29b	59,08a	-	-

(1)Refer to Table 1
(2)Different letters within the same row denote significant differences during each stage (P=0.05, N = 36)

and T2 were found with similar C and N contents, C:N ratios and P contents as well as Na, B, Cu and Mn concentrations. However, T2 was found with pH values, K contents, Fe concentrations as well as ash contents that were significantly higher than those of T1. T2 was found with resistance, Ca and Mg, Zn, moisture contents and density values that were lower than those of T1. Although, some chemical parameters of the wine filter waste composts were found in comparable levels to those of commercial composts, most were found in levels that exceeded those of commercial composts. Overall, the wine filter wastes compost produced could be characterised as follows: high pH and low resistance values, adequate N and P, high K contents, excessively high Na and Fe concentrations and with adequate B concentrations that should be closely monitored if the compost is used in the field.

Effects of turning and not turning wine filter waste compost heaps

Temperatures

With all the three-year data combined, T1 (Turn) attained mean temperatures that were significantly higher by 5˚C to 8˚C than those of T1 (No-turn) in all identified composting stages (Table 4). T2 (Turn) reached temperatures that were significantly higher by 3˚C to 5˚C than those of T2 (No-turn) in all composting stages. Turning of heaps therefore resulted in increased temperatures in almost all the composting stages.

Chemical parameters

Turning of compost heaps resulted in significant increases in levels of pH, P, K, Fe and Mn concentrations, however there were decreases in resistance values, C contents, N, C: N ratios, Ca and Mg contents, concentrations of B, Cu, and Zn (T1-Turn only), moisture contents as well as density values (data not shown). Therefore, overall, with the exception of Na, all the chemical and physical parameters of one or both final wine filter waste composts were significantly affected by turning and not turning activities of compost heaps.

Effects of lining and not lining of compost heap surfaces

Temperatures

Composting temperatures as affected by the use of a lining on compost heap surfaces during the various composting stages over the 2012/13-2014/15 period are indicated in Table 5. T1-Lining attained temperatures that were significantly lower by approximately 1˚C than those of T1 No-lining during Stages 60 and 90. In contrast, during the rest of the stages T1-Lining attained temperatures that were higher by 1˚C than those of T1 No-lining. T2-Lining attained temperatures that were higher by 1˚C than those of T2 No-lining during Stage 60. However, T2-Lining attained temperatures that were higher by approximately 1˚C and 2˚C, during Stages 75 and 90, respectively. Therefore, overall 3 composting seasons, temperatures were found generally higher in lined compost heaps than unlined compost heaps during most composting stages and T1 was generally more sensitive to the use of a lining than T2.

Chemical parameters

Chemical and physical parameters of final winery solid waste composts from lined and not lined compost heap surfaces produced during the 2012/13-2014/15 period are indicated in Table 6. Overall, the use of a lining on composting surfaces resulted in increased pH levels, C and N contents, C: N ratios, P, K, Ca and Mg contents, Na and B concentrations, moisture levels, and decreased Fe and Cu (T1-Lining only) concentrations and ash contents in final wine filter waste composts.

Effects of seasons on wine filter waste composting process and characteristics of final compost

Temperature

The highest mean temperatures for both T1 and T2 were measured during 2013/14, while the lowest in 2014/15 (data not shown). Overall, T1 attained the highest and the lowest mean temperatures during the 2013/14 and 2014/15 compost production periods, and was therefore more sensitive to seasonal changes than T2, as T2 was not affected significantly by seasonal changes (data not shown). Climatic conditions

TABLE 4

Temperatures of turned (Turn) and not turned (No-turn) winery solid waste compost heaps (sub-treatments) produced during various composting stages of the 2012/13 to 2014/15 period.

Composting stages	Temperatures(˚C)					
	T0[1]-Turn	T0 No-turn	T1[1]-Turn	T1 No-turn	T2[1]-Turn	T2 No-turn
60	23.27ij[2]	20.21opq	32.85a	25.42f	26.02ef	24.58g
75	22.42kl	20.23opq	28.48b	23.01jk	27.99bc	23.77hi
90	23.58hij	20.62o	27.38cd	22.06lm	27.17d	22.50kl
105	22.94jk	19.59qrs	27.15d	21.35n	26.36e	21.45mn
120	23.07jk	19.93pq	27.30d	20.45op	24.25gh	20.10opq
135	21.89lmn	19.01s	24.19gh	19.11rs	23.28ij	19.73qr

[1]Refer to Table 1

[2]Different letters within the same rows and columns denote significant differences during all stages (P=0.05)

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TABLE 5
Temperatures of lined (Lining) and not lined (No-lining) winery solid waste compost during different composting stages of the 2012/13-2014/15 period.

Composting stages	Temperatures(˚C)					
	T0[1] -Lining	T0 No-lining	T1[1] -Lining	T1 No-lining	T2[1] -Lining	T2 No-lining
60	22.21kl[2]	21.28mnopq	28.73b	29.54a	24.74gh	25.86cd
75	20.89nopq	21.76klmn	26.41c	25.08efg	26.29c	25.47def
90	22.39k	21.81klmn	24.32hi	25.12efg	25.74cde	23.89ij
105	20.78pqr	21.75klmn	24.91fgh	24.00j	23.96ij	23.85ij
120	21.55lmno	21.45mnop	24.48ghi	23.27j	21.96klm	22.39k
135	20.31r	20.59rq	22.17kl	21.13nopq	21.70klmn	21.32mnop

[1]Refer to Table 1
[2]Different letters within the same rows and columns denote significant differences during all stages (P=0.05)

TABLE 6
Chemical and physical parameters of winery solid waste composts from lined (Lining) and not lined (No-lining) compost heap surfaces produced during 3 seasons (2012/13-2014/15).

Parameters	Sub-treatments					
	T0[1] -Lining	T0 No-lining	T1[1] -Lining	T1 No-lining	T2[1] -Lining	T2 No-lining
pH	6.54d[2]	6.49d	8.98b	8.53c	9.56a	8.96b
Resistance(Ohm)	201b	214a	66cd	71c	60d	66cd
C(%)	23.50a	19.01b	18.86b	13.80c	17.74b	14.40c
N(%)	2.02b	1.70d	2.42a	1.94bc	2.32a	1.89c
C/N	12a	11b	8c	7d	8cd	8cd
P(%)	0.12c	0.11d	0.29a	0.22b	0.31a	0.22b
K(%)	0.99e	0.83e	4.54b	2.58d	5.46a	3.05c
Ca(%)	0.93a	0.79b	0.62c	0.51d	0.55d	0.45e
Mg(%)	0.25a	0.21b	0.13c	0.09d	0.10d	0.08e
Na(mg/kg)	992d	879d	4206b	3081c	4372a	3143c
B(mg/kg)	33.50c	28.93d	51.02a	40.34b	53.17a	41.16b
Fe(mg/kg)	4902d	7580b	6459c	8875a	6928bc	9697a
Cu(mg/kg)	21.52a	21.66a	15.36c	17.67b	17.05b	16.62bc
Mn(mg/kg)	53.25a	51.92a	46.61b	45.51b	45.75b	44.16b
Zn(mg/kg)	56.92a	40.66b	33.16c	31.16cd	29.27de	26.16e
Moisture(%)	66.73a	60.99cd	67.86a	61.91c	65.06b	60.23d
Density(kg/m^3)	676c	689c	856a	858a	821b	823b
Ash(%)	22.26f	36.03e	51.24d	59.34b	55.97c	62.19a

[1]Refer to Table 1
[2]Different letters within the same row denote significant differences (N=18, P=0.05)

such as day temperatures and humidity during composting seasons 2013/14 and 2014/15, together with the combination of winery waste materials making up T1 probably resulted in increases in composting temperatures.

Chemical parameters

Chemical and physical parameters of winery solid waste composts as affected by composting and waste production seasons are indicated in Table 7. The wine filter waste compost parameters that were mostly affected by the

TABLE 7
Effect composting and waste production period on chemical and physical parameters of final winery solid waste composts.

Parameters	T0[1]			T1[1]			T2[1]		
	2012/13	2013/14	2014/15	2012/13	2013/14	2014/15	2012/13	2013/14	2014/15
pH	6,85d[2]	6,47e	6,27e	8,97b	8,84b	8,45c	9,47a	8,99b	9,36a
Resistance(Ohm)	268a	176b	168c	76d	59f	70de	68e	57f	63ef
C(%)	16,53cd	23,60a	23,63a	14,19e	16,11d	18,70b	14,90de	14,90de	18,41bc
N(%)	1,98cd	1,64e	2,00cd	2,41a	1,88d	2,25b	2,43a	2,02c	1,87d
C/N	7,99de	14,39a	11,35b	5,75f	8,57d	8,25de	6,06f	7,44e	9,72c
P(%)	0,15f	0,09h	0,11g	0,30b	0,20e	0,27c	0,32a	0,23d	0,24d
K(%)	0,92e	0,96e	0,86e	4,42b	3,10d	3,03d	5,62a	3,36d	4,01c
Ca(%)	1,05a	0,75b	0,78b	0,63c	0,53de	0,54d	0,54d	0,48f	0,49ef
Mg(%)	0,29a	0,23b	0,18c	0,15d	0,13e	0,05g	0,12ef	0,11f	0,04h
Na(mg/kg)	918g	735g	1154f	5018b	2992cd	2905d	5455a	3160c	2657e
B(mg/kg)	31,52c	30,18c	31,78c	44,57b	46,36ab	46,64ab	48,99a	44,73b	47,77a
Fe(mg/kg)	5788d	8377c	4558e	6108d	11781b	5113de	5645de	13670a	5622de
Cu(mg/kg)	42,48a	16,11cd	14,89de	20,30b	17,63c	11,07f	20,87b	16,16cd	13,46e
Mn(mg/kg)	60,34a	47,04cd	50,38bc	53,95b	41,79ef	41,82ef	50,53bc	39,09f	45,24de
Zn(mg/kg)	60,68a	47,49b	39,27c	42,05c	26,11ef	28,05de	31,52d	23,43f	28,19de
Moisture(%)	66,80b	63,78c	61,00de	68,98a	62,43cd	63,83c	67,58ab	60,43e	59,92e
Density(kg/m)	680de	716cd	652e	849b	888a	834b	870ab	853ab	745c
Ash(%)	30,81d	29,39d	26,85e	56,57b	56,72b	52,58c	58,88ab	59,67a	58,70ab

(1)Refer to Table 1
(2)Values within the same row with different letters denote significant differences ($P = 0.05$, $N = 36$)

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differences in composting seasons and waste production periods were C and N contents, C/N ratios, P, K and Mg, Na, Cu and Mn concentrations. T1 contained the lowest C contents in 2014/15 and highest in 2012/13. Both T1 and T2 contained the highest N contents during 2012/13, but for T1 the second highest were those of 2014/15 while for T2 those of 2013/14 (Table 6). T2 was found with the lowest C/N ratios during 2012/13, while the highest in 2014/15. T1 was found with the highest P levels in 2012/13 and the lowest in 2013/14.

T2 obtained the highest K levels in 2012/13 and the lowest in 2013/14. T1 contained Mg levels that were highest in 2012/13 and lowest in 2014/15 (Table 7). Sodium levels of T2 were the highest in 2012/13 and lowest in 2014/15. Copper levels of T1 were the highest in 2012/13 and lowest in 2014/15. Similarly, for T2, Cu levels were the highest in 2012/13 and lowest in 2014/15. T2 was found with the highest Mn levels in 2012/13 and lowest in 2013/14. Therefore, most of the chemical and physical parameters of both T1 and T2 were affected significantly by weather variations during composting seasons.

DISCUSSIONS

Compost quality

Over all three seasons of compost production, turning and lining of compost heaps significantly affected temperatures and some physical and chemical characteristics of the WFW composts. Turning of compost heaps significantly increased temperatures during composting. Also, turning of compost heaps significantly increased levels of pH, K, P, Fe, ash content, while decreasing resistance values, C and N contents, C/N ratios, Ca and Mg contents, Cu and B concentrations, density values and moisture contents in both final WFW composts.

Furthermore, WFW composts can be characterised as follows: pH (9.8), resistance (58 Ohm), C: N ratios (8:1) and total contents of N (2.44%), P (0.34%), K (≈6%), Na (3665 mg/kg), B (54 mg/kg) and Fe (5643 mg/kg). The low resistance values were an indication of a presence of large amounts of salts, which was reflected by excessive Na levels. The low C: N ratio, indicated that WFW composts may be quick to release N upon application. Total P and K levels pointed to WFW composts being potential good sources of these nutrients, however, high total B levels were bothersome, and should be monitored closely upon application. Moreover, the WFW composts could be characterised as rich in Fe, but its availability to plants may be limited by alkaline conditions of the compost and competition for uptake by other micronutrients. In addition, some WFW compost parameters varied significantly with composting seasons, however, the two composts types were not always affected in the same manner. Nitrogen and Cu contents differed significantly with seasons for both WFW compost types. The high pH values suggest that when using wine filter wastes for composting, there is no need to use additives that are aimed at increasing the pH. Turning of compost heaps increases temperatures, which is a positive factor during composting.

Composting surfaces should be lined and compost production practiced where leachate can be collected, as it alters the chemical composition of the soil. Furthermore, some compost parameters are likely to change from season to season as quantities of wine filter wastes generated seasonally vary. Total K levels that are greater than 0.5% as it is the case with both wine filter waste composts are considered high for composting (Raath & Schutte, 2001). Nonetheless, only when the amount of compost that needs to be applied is determined, then the amount of K that needs to be applied will be known. It is possible that the wine filter waste compost could be beneficial for K deficient soils. Furthermore, wine filter waste composts, especially T2 contained higher K than N contents, which may be negative factor if not corrected during field application, as this may cause nutritional imbalance related problems with time (Raath & Schutte, 2001). Sodium is generally an undesirable salt as it contributes to soil sodicity. Therefore, it can be assumed that the high Na concentrations of the wine filter waste composts may pose a huge problem and an environmental threat. In practice, though the amount of compost that is applied as well as the specific soil's exchangeable Na percentage determines how much Na can be tolerated by individual crops (Raath & Schutte, 2001). Furthermore, when compost is used as an amendment, Na levels could be reduced through the dilution effect of mixing the compost with soil and leaching. Optimal C: N ratios for a finished or ripe compost have been reported to be those between 13:1 and 10:1 and the lower they are as in this study with the wine filter waste composts (8:1), the quicker the N mineral would be available during application. Levels of N, P and B were within the ranges required in compost (Raath & Fourie, 2006). However, a P supplement would be beneficial in practice and B levels would have to be monitored after application to avoid its accumulation.

CONCLUSIONS

The substrates and process parameters for effective composting using wine filter waste materials can now be defined following the method of production of the two wine filter waste composts produced in this study. Wine filter wastes together with grapevine pruning canes and berry skins, seeds and stalks could be used to make compost. A compost pile that has between 40% to 50% of wine filter wastes would result in successful composting and in a final compost product of acceptable chemical composition depending on the quality of the winery waste materials used. Composts made using wine filter wastes reached high temperatures (50 to 67˚C) were alkaline (high pH), potential good sources of K and N. These however had low C: N ratio, rich in Fe, but have excessive Na and high B levels which should be monitored upon application. Turning of compost heaps increases temperatures due to aeration, which is a positive factor during composting. Furthermore, some compost parameters are likely to change from season to season as composting weather conditions, quantities and probably also chemical composition of wine filter wastes generated seasonally, vary. It is therefore important to have wine filter wastes analysed before composting. In addition, the use of more C and N rich material and inoculants could enhance the winery solid waste compost production process.

LITERATURE CITED

Arvanitoyannis, I. S., Ladas, D., & Mavromatis, A., 2006. Wine waste treatment methodology. International J. Food Sci. Technol. 41, 1117–1151.

Bertran, E., Sort, X., Soliva, M., & Trillas, I., 2004. Composting winery waste: Sludges and grape stalks. Bioresource Technol. 95, 203–208.

Bonthuys, J., 2016. Recycling vs incineration. WineLand, 1- 2.

Masowa, M.M., Kutu, F.R., Babalola, O.O. & Mulidzi, R., 2018. Physico-chemical properties and phyto-toxicity assessment of co-composted winery solid wastes with and without effective microorganism inoculation. Res. Crops, 19, 549-559.

Masowa, M.M., Kutu, F.R., Shange, P.L., Mulidzi, R. & Vanassche, F.M.G., 2015. The effect of winery solid waste compost application on maize growth, biomass yield, and nutrient content under greenhouse conditions. Arch. Agron. Soil Sci. 62, 1082-1094.

Mulidzi, A.R., 2021. Assessment & monitoring the feasibility of winery solid waste management through composting. Scientia Agriculturae Bohemica (submitted for publication).

Mulidzi, A.R., 2001. Environmental Impact of Winery Effluent in the Western and Northern Cape Provinces. Thesis, University of Pretoria, Private Bag X20, Hatfield, 0028.

Mulidzi, A.R., Clarke, C.E. & Myburgh, P.A., 2015. Effect of irrigation with diluted winery wastewater on cations & pH in four differently textured soils. SA J. Enol. Vitic. 36, 402 - 412.

Mulidzi, A.R., Clarke, C.E. & Myburgh, P.A., 2016. Effect of irrigation with diluted winery wastewater on Phosphorus in four differently textured soils. SA J. Enol. Vitic. 37, 79 - 84.

Mulidzi, R., Augustine, P., Naude, M. & Van Schoor, L., 2018. Guidelines for making compost using winery solid wastes. Wineland, 72-75.

Mtimkulu, Y., Meyer, A.H., Mulidzi, A.R., Shange, P.L & Nchu, F., 2016. Assessing and monitoring the effects of filter material amendments on the bio physicochemical properties during composting of solid winery waste under open field and varying climatic conditions. Waste Management J. 59, 59-69.

Raath, P. J. & Fourie, J. C., 2006. Guidelines for making compost on a wine grape enterprise. WineLand, 96–97.

Raath, P. J. & Schutte, C., 2001. Guidelines for monitoring soil fertility, plant nutrient status and compost quality in organic wine grape production systems. WineLand, 90–93.

Theron, C., 2013. Integrated Production of Wine (IPW) - the management of solid waste. WineLand, 7.

Zingelwa-Masekwana, N., 2012. Management of fining and filter waste in wineries. WineLand, 115 – 117.

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