CHAPTER 5

INTEGRATED COMPARATIVE DISCUSSION ON THE COMPOSITION OF WINERY EFFLUENTS

5.1 INTRODUCTION

From Chapter 4 it is clear that the composition of winery effluent differs widely from one winery to the other, but there are also some similarities in trends. These differences are assumed to be due to differences in the winemaking processes in different wineries, as well as differences in chemicals, soaps, etc. used to wash the tanks, equipment and floors. Water management in a winery also has an influence on the quality and quantity of effluent.

5.2 EFFLUENT pH

According to the literature, winery effluent is characterized by pH of less than 5.5 (Levay, 1995). In the present study the effluent from all cellars had pH values lower than 5.5 for the whole winemaking period (Table 5.1). In a number of cases the pH values dropped to below 4.0 and in a few even below 3.0. In other words the pH values of the effluents of all the wineries studied are below, in most cases far below, the minimum pH of 6 allowed by the South African Water Act (ACT NO.36 of 1998). For many wineries a sharp decrease in pH coincided with a marked increase in COD. (Compare Tables 5.1 and 5.2) The low pH of winery effluents can, to a large extent be ascribed to citric or tartaric acid used to neutralise the alkali (Van Schoor, 2000).

It is clear that the effluents of all wineries have pH values far below the acceptable levels for most of the year, and that all wineries must take appropriate measures to correct this problem before disposal of the effluent. Except for a few cases of minor reductions in soil pH levels, there does not seem to be indications of acidification of the soils due to effluent application. In a few cases there were even increases in soil pH to high levels. It was not determined how the wineries manage the counteraction of soil acidification, but most of them seem to be doing a good job of it.

According to the literature, the best method is addition of calcium hydroxide slurry at the point where the effluent leaves the storage dam for irrigation (Hazell, 1997).

Table 5.1: pH values of effluents from different wineries (From: Van Schoor & Mulidzi, 2001).

Mon	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	6.4	7.6	5.6	5.3	2.8	4.4	6.1	5.6	4.6	6.6
Jan	2.7	7.4	4.4	6.6	4.7	5.7	7	3.5	7.1	4.1
Feb	5.1	4.4	4.8	4.3	4.1	4.9	3.7	4.3	4	5.1
Mar	5.1	4.6	4.5	5	3.6	4.6	3.7	3.8	4	4
Apr	5	4.8	5.3	3.1	5.4	6.1	4.3	5.1	4.5	4.4
Jun	4.5	5.3	3.7	4.4	-	-	-	3.6	4.8	5.8
Jul	-	6	-	-	-	-	-	-	-	5.7

5.3 COD LEVELS OF EFFLUENTS

From Table 5.2 it is clear that all wineries have COD values above 5 000 mg/l (which is the maximum acceptable value for crop irrigation) at some stage during their winemaking periods. The period of exceedance of the acceptable limit usually lasts for two or three months and usually includes February, March and/or April. In a few cases it starts in January and in no case did it apparently go beyond April. Unfortunately no data were collected during May, but by June COD levels have decrease to low or very low values. There was no possible explanation for the odd high December value for the abnormal cellar from the Olifants River region. Citric acid, grape solids, lees, grape juice, wine and tartrate increases COD of wastewater (Van Schoor, 2001b).

Table 5.2: COD values of effluents from different Wineries (From: Van Schoor & Mulidzi, 2001).

Month	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	2299	364	582	3321	2595	1517	2241	1494	37739	1176
Jan	5296	233	3676	2372	4545	6561	3399	14229	1462	3043
Feb	2700	8520	996	14160	18044	1174	5788	10120	23872	4000
Mar	3373	6190	7262	8175	6627	3770	11270	6389	47024	23571
Apr	7802	2257	7802	12238	1117	448	10614	2805	58812	24752
June	4458	3514	859	3394	-	-	-	1205	-	574
Jul	-	1968	-	-	-	-	-	-	-	980

The values with which COD exceed the acceptable limit for some wineries (Paarl 1, Paarl 2, Paarl 3, Robertson 2) are low, while others range from high (Stellenbosch, Worcester, Robertson 1, Berg River) to extremely high (Orange River, Olifants River).

Some regional trends were observed: All three cellars from the Paarl region (Paarl 1, 2 and 3) did not exceed the acceptable limit by much. Cellars from further inland, i.e. from the Berg river, Worcester and Robertson regions (Berg River, Worcester, Robertson 1) had high exceedance levels, while both cellars from the dry northern Olifants and Orange river regions had extremely high exceedance levels. Since only a small number of cellars were studied in each region, these cannot be regarded as rules at this stage, but it warrants further investigation. Robertson 2 already does not fit into its group, being much better than the rest of the group in terms of COD. The poor quality effluent from the one Stellenbosch winery can also not be taken as representative of the whole Stellenbosch region.

It is accepted that ethanol and sugars are the main contributors to high COD values in wine cellar effluents (Glaetzer, 1998). Suspended and colloidal organic matter in cellar effluent is usually also a significant contributor to the total pollution load as measured by COD (Levay, 1995). In the present study the organic fractions responsible for high COD values were not determined. It is clear that effluents from all the wineries had COD levels above the acceptable maximum limit for two to three months each year. During these periods the effluent will have to be treated **before** disposal to reduce the COD to acceptable levels.

From the present study it is clear that aerobic decomposition of the organic matter, especially at the wineries with high COD effluents, does not take place in the soil and that the organic substances percolate through the soil to the water table where it undergoes anaerobic decomposition or seeps through to ditches or streams (see Chapter 7). The wineries do not seem to have appropriate, if any, management systems in place to deal with the problems of high COD levels. They may be under the false impression that aerobic decomposition of the organic fraction of the effluents occurs in their soils, which is clearly not the case.

5.4 SAR AND SODIUM

Table 5.3 shows that the effluent from three of the wineries had **SAR** values above 5 (which is the maximum acceptable value for crop irrigation) during December and January. In December an additional winery had effluent with a SAR above the acceptable level, while another one fell in this category in January. Caustic soda is the main source of sodium (Van Schoor, 2000).

The effluents from four wineries had unacceptably high SAR values in March. Two of these did not have such problem in December or January. Although the effluents from the Robertson 1 winery had high SAR values only in December and January, these values were extremely high. The Paarl 2 winery is the only winery of which the effluents had high SAR values throughout all months. This was attributed to the use of poor quality borehole water in the cellar. In contrast the effluents from the Paarl 3, Robertson 2 and Berg River wineries had very low SAR values throughout the whole study period.

Table 5.3: SAR values of effluents from different wineries (From: Van Schoor & Mulidzi, 2001).

Mont	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	5.7	7.5	0.6	2.4	0.7	1.9	29.0	1.2	5.8	1.2
Jan	1.8	7.8	0.5	4.9	7.1	1.8	33.1	0.5	10.8	1.7
Feb	1.2	6.3	3.2	4.4	3.5	2.0	1.9	0.6	1.5	1.7
Mar	4.4	7.1	0.8	9.1	6.5	2.1	4.5	0.5	2.3	9.5
Apr	1.6	10.0	0.8	2.1	2.3	2.4	1.7	0.3	2.8	0.9
Jun	1.8	12.0	0.9	3.6	-	-	-	0.4	1.0	1.0
Jul	-	11.2	-	-	-	-	-	-	-	1.4

It is clear from Table 5.4 that the effluents from certain wineries have high sodium levels in some months. Logically these coincide with the cases with high SAR values.

According to Glaetzer (1995) sodium enters the wastewater stream via the use of cleaning chemicals such as caustic soda (sodium hydroxide) and sodium hypochlorite. As indicated earlier, the biggest problem case in the present study (Paarl 2) was related to the use of poor quality borehole water and not to chemicals used in the cellar. High sodium levels will imbalance the cations and anions present in the soils, leading to a degradation of soil structure and thus permeability. In the present study dispersion of clay and subsoil compaction have been observed as on-site problems caused by sodium in one case. In the two wineries where high sodium is the biggest problem (Paarl 2 and Robertson 1) the biggest concern is about off-site effects of sodium leaching into adjacent streams, causing sodicity problems elsewhere.

Table 5.4: Sodium levels (mg/l) in effluents from different wineries (From: Van Schoor & Mulidzi, 2001).

Mont	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	206	261	8.8	61	5	59	692	24	252	40
Jan	61	305	10.7	86.3	107.2	61.12	677.8	15.7	322.6	55.14
Feb	33	269	77.7	127.9	59.2	71.1	35.1	15.7	51.6	53.2
Mar	152	311	29.6	251.5	107.9	66.4	130.5	10	97.1	387
Apr	85	448	13.7	60.1	24.9	80.2	38	6.2	109.7	28.7
Jun	66	513	11.3	58.8	-	-	-	8.3	90.4	29
Jul	-	446	-	-	-	-	-	-	-	41.5

The wineries where high sodium and SAR levels in the effluent pose problems do not seem to have appropriate management systems in place to counteract this. This can be seen in the relationships between elevated ESP levels in the soils of the disposal sites and effluent SAR values. ESP and SAR both reflect Na:(Ca + Mg) ratios.

5.5 EC AND CHLORIDE

5.5.1 EC (Electrical conductivity)

Table 5.5 indicates that few wineries have effluents with EC values above 200 mS/m (which is the maximum acceptable value for crop irrigation) at some stage during their winemaking periods. High electrolyte contents in effluents, therefore, do not seem to pose any problem at the vast majority of wineries.

In contrast to this general favourable pattern, two wineries (Olifants River and Paarl 2) have EC values above 200 mS/m in **all** months. Not only did the effluents from these wineries have high electrolyte concentrations throughout the whole period, but the values were very high. In the case of Olifants River the values were extremely high. The implication is that the effluents from both wineries have very definite salinization hazards, both on-site and off-site. Unfortunately EC was not determined on the pre-winemaking samples (December and January), when the values might have been high at more wineries. This will have to be followed up.

Table 5.5: EC values of effluents from different wineries (From: Van Schoor & Mulidzi, 2001).

Mont	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	-	-	-	-	-	-	-	-	-	-
Jan	-	-	-	-	-	-	-	-	-	-
Feb	82	269	60	150	65	544	60	95	524	88
Mar	109	311	137	170	66	92	144	76	1008	253
Apr	386	448	175	143	44	177	90	184	2340	125
Jun	170	513	52	74	-	-	-	110	2570	67
Jul	-	313	-	-	-	-	-	-	-	62

5.5.2 Chloride

From Table 5.6 it is clear that the effluents from the majority of the wineries had acceptable chloride levels, i.e. below 200 mg/l, throughout the study period. There is a unique situation with one winery (Paarl 2), where the effluents had extremely high chloride levels throughout all months, which was also, like the high sodium levels, related to the poor quality borehole water used.

Other wineries that showed high amounts of chloride in effluents in some months are Paarl 1, Stellenbosch and Orange River. It is only Stellenbosch (January) and Orange River (March) that have very high values. The reason for the high amounts of chloride in effluents is not known, but may possible be due to the use of a chemical such as hypochlorite to combat fungal growth.

Table 5.6: Chloride levels (mg/l) in effluents from different wineries (From: Van Schoor & Mulidzi, 2001).

Mont	Paa 1	Paa 2	Paa 3	Stell	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	-	-	-	-	-	-	-	-	-	-
Jan	98	286	98	632.6	49.89	76.6	55.24	126.5	48.11	126.5
Feb	173	869	96	133	19	66	86	63	158	105
Mar	130	760	54	42	27	87	166	43	86	456
Apr	132	470	58	66	73	45	141	28	134	46
Jun	116	704	27	55	-	-	-	27	0	46
Jul	-	-	-	-	-	-	-	-	-	-

5.6 POTASSIUM

Table 5.7 indicates that all the wineries, except one (Robertson 2), had effluents characterized by high potassium at some stage during the study period. The effluents from the Berg River winery constantly had high potassium levels throughout the whole study period. The effluents of the winery from the Olifants River region had very high potassium values throughout the sampling period (Table 5.7), in line with the abnormally high levels of all elements analysed for at this winery. At both these wineries the soils at the disposal site are not sandy, as is the case at most other wineries, so the potassium can be retained on adsorption sites in the soil.

Potassium is not toxic to plants, but high potassium levels may upset nutrient balances in the soil, especially K:Mg balances. From the soil data obtained in this study it transpired that there is a lot of leaching of potassium in and from the effluent treated soils at some cellars, creating definite eutrophication hazards for adjacent streams. This is especially the case where the effluent is applied on the light gray, highly leached sandy soils.

Table 5.7: Potassium values (mg/l) for effluents from different wineries (From: Van Schoor & Mulidzi, 2001)

Mont	Paa 1	Paa 2	Paa 3	Stelle	Worc	Rob 2	Rob 1	Berg	Olif	Oran
Dec	-	-	-	-	-	-	-	-	-	-
Jan	32	163	40.3	61.7	100.8	137.5	107	264.9	388.7	48.7
Feb	125	267.7	15.3	356.7	127.2	95.1	93.1	279.9	1449	75.1
Mar	65	313.7	334.1	333.2	124.6	89.9	298.5	242.5	4119	295.9
Apr	336	113.7	290.6	97	19.5	48.7	79.6	311.6	5578	103.9
Jun	211	244.8	85.4	64.9	-	-	-	279.7	6896	19.2
Jul	-	-	-	-	-		-	-	-	-