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Characterisation of effluents from ribbed smoked sheet processing units and water from nearby wells

Jacob Mathew, Juliya Rani Francis*, Kochuthresiamma Joseph and Geetha Jose

Rubber Research Institute of India, Kottayam-9, Kerala.

Abstract

Effluents from twenty Ribbed Smoked Sheet (RSS) processing units and the well water from the same compound were studied for the pollution parameters. The effluents were acidic and were above the recommended safe limits with regard to total solids, dissolved solids, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and nitrogen. The total bacterial and the Most probable Number (MPN) counts for coliforms were also high. Ninety per cent of the well water near the processing units were acidic with pH less than 6.5, which is below the minimum standard prescribed. However, other physico-chemical parameters were within the safe limit. But the total bacterial and MPN counts for coliforms in all the well water samples were high. Organic contamination of these wells, which may favour pathogenic bacterial contamination, is indicated by the presence of *E.coli* in the wells. But the pH of the wells in an area away from rubber processing units was within the safe limit. These wells were also free from contamination by *E. coli*. Since the wells near the effluent disposal points showed higher values for the various parameters, probable influence of the processing effluent is suspected.

Key words: Ribbed Smoked Sheet processing, effluent, contamination, coliforms

Introduction

More than 60 per cent of the natural rubber in India is processed in the form of Ribbed Smoked Sheets (RSS). The water content in latex, water used for its dilution prior to coagulation, organic non-rubber substances in latex and the acid used for coagulation constitute the effluent of sheet processing. On an average, 10 L of wastewater is disposed as liquid waste per kg of dry rubber. This effluent containing proteins, sugars, lipids, carotenoids, inorganic and organic salts forms a very good substrate for the proliferation of microorganisms (RRIM, 1974). As the types of RSS processing units are numerous and scattered throughout the rubber growing areas, they pose serious environmental concern.

Most of the RSS processing units are in small homestead rubber plantations, which have wells in the same compound. The water from the wells is utilized both for rubber processing and for domestic purposes. As the effluent from the processing unit is often disposed off to the same land without any treatment, it may contaminate the nearby well water. Hence a study was carried out to assess the pollution load of the RSS processing effluents and the microbial contamination in the nearby wells.

Materials and Methods

Twenty RSS processing units in the Kalloorkad Panchayat of Ernakulam District were selected for the study. The daily production of RSS and the quantity of effluent generated were recorded. Effluents from these units were collected from the disposal end of the processing unit. Twenty water samples were also collected from the wells in the same compound where the processing units were situated. Water samples from five wells from an area with no RSS processing units

* *Present address: - Department of Microbiology, Sree Sankara College, Kalady-683 574.*

served as control. Effluent and water samples were collected in polythene containers for physico-chemical properties and in sterilized bottles for bacteriological analysis. Distance of the wells from the processing units was also measured. Effluent and water samples were analysed for the following physico-chemical and bacteriological properties as per the standard methods (APHA, 1974).

The physico-chemical parameters studied included pH. electrical conductivity (EC), total solids (TS), dissolved solids (DS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO) and Total Hardness (TH)

The microbial assay of the effluent was also performed following standard procedures. The bacteriological observations recorded were total count, Most Probable Number (MPN) count presence and number of coliforms, presence of faecal coliforms and *E. coli*.

Results and Discussion

Survey of RSS processing units

The average production of RSS in the processing units under study was 20 kg/day and the generation of effluent was 10 L/kg of dry rubber. The effluent was commonly disposed to the land nearby in these units without any treatment. The mean distance between the processing unit and the wells was 16.22 m, the recommended minimum being 15 m.

Characterisation of the effluents

The various physico-chemical properties of effluent are presented in Table 1. All the effluents studied were acidic in nature. The pH ranged from 3.9 to 6.0. The acidic nature of the effluent is due to the addition of organic acids for the coagulation of the latex (Kuriakose and Thomas, 2000). The low pH induces the formation of trihalomethanes which are toxic and pH below 6.5 causes corrosion in pipes thereby releasing toxic metals such as Zn, Pb. Cd and Cu. (Trivedy and Goel, 1991). The electrical conductivity varied from 3.69 to 7.97 mS cm^{-1}, the average being 5.96 mS cm^{-1}. The high range of conductivity shows the presence of salt in the effluent (Trivedy and Goel, 1991).

The minimum level of total solids was 20,350 and the maximum 30.000mg/L. The dissolved solid varied from 14,420 to 27,630 mg/L. the safe limit being 21.000. In all the effluent samples, the levels of TS and DS were above the safe limit (Table 1). The high level of DS indicates the higher conductivity of the effluent (Trivedy, 1989).

The biochemical oxygen demand (BOD) varied from 9,948 to 18.708 mg/L in the effluents, the safe limit being 100 mg/L for irrigation. The higher level of BOD indicates the organic pollution due to these effluents. The minimum level of chemical oxygen demand (COD) was 20,000 mg/L. Since safe limit (KSPCB, 1997) recommended is 250 mg/L for irrigation, all the effluent

Table 1. Physical, chemical and bacteriological characteristics of the effluent from RSS processing

Effluent Sample No.	pH	EC (mS cm^{-1})	Total solids (mg/L)	Dissolved solids (mg/L)	BOD (mg/L)	COD (mg/L)	Total Nitrogen (mg/L)	MPN/ 100 (ml)	Total count (10^8/ml)
01	4.4	5.50	27. 645	24, 842	15,232	26. 400	1022	17	62
02	4.6	7.59	21. 445	18, 965	13.994	26, 400	938	5	55
03	4.6	5.07	20. 350	18. 465	12. 757	20. 800	504	4	8
04	4.6	5.93	26. 425	23. 810	15. 803	28. 800	714	4	20
05	4.6	5.05	27. 140	25. 335	15. 739	28. 000	546	2	9
06	4.9	7.97	21, 610	17. 843	13. 138	25. 333	602	5	25
07	6.0	6.28	29, 260	27. 630	17. 453	39. 467	532	4	10
08	4.6	8.28	20. 620	18. 342	13. 090	24. 400	966	5	26
09	4.0	6.68	24. 825	22, 120	14, 423	30. 400	742	2	2
10	4.5	5.27	18. 620	16. 225	9. 948	21, 600	490	22	166
11	4.2	4.37	17. 230	14. 420	16. 061	20. 000	490	4	37
12	3.9	6.47	20. 720	17. 530	16, 234	26. 800	756	2	3
13	4.5	6.75	21. 340	19. 235	16. 981	28. 000	644	33	104
14	5.3	3.69	21. 510	18. 925	17, 967	28. 800	238	17	70
15	5.0	6.12	29. 400	26. 638	18. 708	36. 400	742	17	46
16	4.9	5.25	21. 900	17. 989	12. 630	31. 600	504	14	87
17	4.4	4.25	28. 889	25. 382	17. 263	35. 200	518	4	34
18	4.9	6.20	28. 300	26. 550	17. 263	36. 800	952	350	143
19	4.7	6.08	27. 900	20. 504	11. 900	20. 800	364	33	23
20	4.0	6.54	30. 000	25, 546	13. 498	25. 200	910	6	31

Table 2. Physical, chemical and bacteriological characteristics of well water

Sample No.	pH	EC (mS cm^{-1})	DO (mg/l)	DS (mg/l)	TH	MPN/ 100ml	Total count (10^3/ml)	Distance of well from processing unit (m)
S1	5.7	0.25	8.6	72	60	280	32	2.5
S2	5.2	0.3	5	160	62	540	13	3.6
S3	6.7	0.27	6.1	170	24	920	196	2.8
S4	5.7	0.31	7.6	110	40	17	8	38
S5	5.6	0.29	7.3	120	17	920	6	3
S6	5.9	0.32	7.3	168	24	33	107	25
S7	6.6	0.28	8	190	84	110	19	50
S8	5.9	0.27	6.8	98	70	280	18	3
S9	5.8	0.27	7.2	75	40	>2,400	4	3.5
S 10	6.7	0.32	5.3	115	25	34	90	3.2
S 11	5.2	0.35	5.8	164	68	1600	4	2.75
S 12	5.3	0.3	5.5	178	105	920	10	2.5
S 13	5.8	0.3	6.1	155	65	920	11	5
S 14	4.9	0.3	5.3	145	85	>2,400	9	15
S 15	6.4	0.41	7.2	90	110	>2,400	69	2.5
S 16	5.9	0.28	6.8	110	68	12	40	22
S 17	5.4	0.33	6.1	165	117	43	122	15
S 18	6.2	0.28	7.1	98	60	1600	16	6
S 19	5.4	0.28	5.8	210	132	>2,400	15	2.5
S 20	5.6	0.29	6	190	125	33	10	40
C21	6.7	0.3	7.9	55	15	-	15*	-
C 22	6.5	0.28	7.6	60	18	15	28*	-
C 23	6.3	0.32	7.7	58	20	-	12*	-
C 24	6.5	0.3	8	45	16	-	18*	-
C 25	6.7	0.28	8.2	50	18	17	14*	-

S= Samples from area near to processing C= Control away from processing area

samples were highly polluted. The level of total nitrogen in these effluents also varied from 238 to 1022 mg/L. As the safe limit is 100 mg/L, these effluents can contaminate the environment if disposed untreated. High nitrogen content in the effluent also can contaminate the drinking water sources, if converted to nitrate and nitrite (Ibrahim, 1980).

Bacteriological properties of the effluent

The bacterial population in the effluent in general was high (Table 1). The total bacterial count in the various effluents ranged from 2 to 166x10^8/ml. The MPN count of coliforms varied from 2 to 350 per 100 ml. All the samples showed the presence of coliforms. All the effluents except two contained *E. coli*. The presence of coliforms especially *E. coli* indicates the possible contamination with pathogenic bacteria (Pipes, 1982).

Characteristics of well water

The water from the wells near the processing units and also from processing free area were analysed for the various drinking water parameters and the results are given in Table 2. Water from all the wells were colourless and odourless.

The pH of the well water was also acidic ranging from 4.9 to 6.7. Among these, 18 samples recorded pH below 6.5. At the same time, well water taken as control recorded higher pH (Table 2). The low pH of the well water might be due to the seepage of acidic effluent from the nearby processing units. Not much difference in pH and EC could be observed for the well water from wells near the processing units irrespective of the distance (Table 3). But there was significant difference with regard to pH between the wells near the processing units and those situated in processing unit free area, indicating

Table 3. Comparison of well water from processing area with control

Source	pH				EC			
	Distance<15m		Distance>15m		Distance<15m		Distance>15m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Near processing area	5.85	0.5466	5.73	0.4949	0.3027	0.0449	0.2966	0.0193
Control	6.54	0.1673	6.54	0.1673	0.296	0.0167	0.296	0.0167
t	-2.71**		-3.511**		0.318 NS		0.0598 NS	

possible contamination by effluents. The low pH in the wells near the processing units even at a distance greater than 15m indicates that the effluent could contaminate the wells even beyond the currently stipulated safe distance.

The dissolved oxygen, DS, total hardness and nitrate content in all the wells were within the permitted limits (Table 2).

Bacteriological properties of well water

The bacteriological properties of well water are presented in Table 2. The minimum and maximum MPN count of coliforms in the well water were 12 and above 2400 per100 ml respectively. Among them, six wells had bacterial population above 1,000. These were located within a distance of 15 m from the processing unit. Out of the 20 wells situated near the processing unit, all showed the presence of coliforms and 19 of them, the presence of *E. coli*. The presence of coliforms, especially *E. coli*, indicates the possibility of organic contamination of these wells which favour pathogenic microorganisms (Bitton, 1999). The total bacterial count in the well water also ranged from 4 to 196 x10^3/ml. The control samples did not contain *E. coli*. Among these, three wells were free from coliforms. However, the total bacterial count in these wells ranged from 12 to 28 x10^3/ml. These bacteria may be soil or animal borne. The absence of coliforms and *E. coli* indicates that the wells are free from any external contamination like processing water or sewage.

In order to avoid the contamination, the minimum distance recommended for the drinking water source is 15 m away from any wastewater source. However, the processing units studied did not have any type of effluent treatment system or collecting tanks. Instead, the effluent was allowed to flow freely in the land. This might be the reason for the contamination of the well even at a distance beyond the stipulated safe limit.

Since the effluents were highly polluted, disposal to land without treatment must be discouraged. This study also suggests the need for keeping drinking water sources away from the processing units.

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