



STUDY ON CHEMICAL CHARACTERIZATION OF PARBOILED RICE MILL EFFLUENTS OF MIRYALAGUDA, NALGONDA DIST., T.S.

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Industrialization has a negative impact on life when discharges are not treated, which can result in water and soil pollution. The regulatory treatment of contaminants is continually changing to more stringent standards in order to protect the environment overall quality and public health. As a result, organic contaminants have become a major challenge in the industrial wastewater treatment process.

Parboiled rice mills make a major contribution to the pollution of water bodies and the environment by releasing significant volume of effluent as waste water. The objective of this study was to assess the amount of organic pollution in wastewater produced from parboiled rice mills in the town of Miryalguda, Nalgonda dist, Telangana state (India). Three separate parboiled rice mills were used to obtain the waste water samples. In accordance with the recommended APHA protocol, the samples were examined for pH, Electrical conductivity, Total hardness, Total Dissolved Solids (TDS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), Chlorides, Phosphates, Calcium, and Magnesium.

The parboiled rice mill effluents were chemically characterized, and the results revealed that the pH (5-6.5), EC (1521-1582 $\mu\text{S}/\text{cm}$), BOD (2395-2698), COD (6402-7102), Total Hardness (511-548), Calcium (166-256), Magnesium (32-40), TDS (1459-1872), and Phosphates (22-34). The results of the physicochemical examination show that all of the samples are contaminated and have values greater than permissible limits. Few more corrective and preventive steps to be made to prevent water pollution by the parboiled rice mill effluents.

Keywords: Parboiled rice mills, APHA, BOD, COD, and Chemical Characterization.

1. Introduction

The rapid industrialization throughout the world particularly due to the alarming rise in the human population has been responsible for a terrible amount of environmental pollution. It is negatively impacted the environmental quality [Ali, S.H *et al.*, 2018], particularly aquatic life due to the discharge of these voluminous amounts of effluents into natural water bodies, on a daily basis without any pretreatment all over the world [Ganeshwade, R.M *et al.*, 2006; Agrawal, A *et al.*, 2010; Edokpayi, J.N *et al.*, 2017]. In developing and underdeveloped countries, effluents from different industries are indiscriminately released into water bodies and even into adjacent fields without any pre-treatment, thus creating serious problems for the non-target beneficial organisms.

Man-made activities result in the development of modern methods in industrialization, urbanization agriculture which increases the release of different industrial effluents such as chemical pollutants, toxicants, biocides, pesticides, and chemicals. These industrial effluents sooner or later reach the aquatic environment and become responsible for its degradation [Dautremepuits C.*et al.*,2004; Wang WX 2002]. Aquatic ecosystems were increasingly vulnerable due to unmonitored and unregulated release of untreated industrial agricultural and municipal polluted effluents throughout the world [Kaur R, Dua A. 2016].The effect of these chemical compounds on the aquatic ecosystem not only depends on their quality, quantity, toxicological, and genotoxic potential but also physic-chemical characteristics of the recipient water body (whether lentic or lotic, sedimentation rate, salinity, temperature, etc.).Water bodies pollution will affect the physicochemical characteristics of the water bodies, which leads to the systemic destruction of the ecosystem structure at the community level, thus disturbing the delicate food web, which in turn is hazardous to human health by biomagnification [Chaplen FWR et al 2007; Koklu R *et al.*, 2010; Patil PN *et al.*, 2012].

The study of physicochemical parameters is essential for getting an accurate picture of water quality, and we can compare the results of various physical and chemical parameter values to standard values. Basawaraj Simpi et al. (2011) investigated monthly changes in physico and chemical parameters of the Hosahalli water tank in Shimoga district of Karnataka.The study shows that all parameters are within the acceptable range, and tank water is unpolluted, allowing it to be used for domestic, irrigation, and fisheries purposes. Saravanakumar and Ranjith Kumar (2011) present research on groundwater quality in Ambattur industrial area of Chennai city. physico-chemical parameters like pH, alkalinity, hardness, turbidity, chloride, sulphate, fluoride, total dissolved solids, and conductivity were all investigated in this study. There was a small variation in the physico-chemical parameters, which was observed among the water samples studied. Physico-chemical parameters of the water sample were compared to WHO and ICMR limits, revealing that the groundwater is highly contaminated and poses a health risk to humans.

Food grains were processed before cooking at the family level a few decades ago, but industrial growth and worldwide strong competitive trends; it has become a major industrial activity in the small and medium sector to meet the demands of an ever-increasing population. Parboiling is a common and dominant rice processing method that usually requires a large amount of ground water. A large number of mills engaged in rice processing/milling are located in almost every state across the country. Waste waters from rice mill operations contain high levels of inorganic and organic substances, leads to significant pollution. The high COD, salinity, total dissolved solids, suspended solids and conductivity continue to pose an economic issue for such industries since these have been used as major parameters.

Small-scale parboiled rice mill requires 900 to 1200 L of Groundwater 1 per tone of rice paddy. During the parboiling process the water will become unusable because of water is with high BOD, COD, TDS, and TSS loads [Malik, K *et al.*, 2011]. After initial treatment, the effluent is discharged directly drained into river or discharged in the fields. The Chemical Oxygen Demand (COD) of this rice mill effluent typically ranges from 2000 mg/L to 7000 mg/L. Effluent mainly contains minerals, dissolved carbohydrates and is acidic in nature with pH ranges from 4.5 to 5.5.

Rice properties are known to be affected by rice variety, cultivation methods, cooking and processing conditions. Vitamins, Minerals, Proteins and fats are concentrated in the germ and outer layer of the starchy endosperm [Juliano, B.O.and Bechtel, D.B 1985; Itani, T *et al.*, 2002], which are removed by milling and polishing process. Although the parboiling process helps to retain some essential nutrients and seals cracks found in the rice, causing the rice become more harder and resulting in an increased milling yield with less breakage and higher head rice recovery (proportion of paddy rice that retains 75% of its length after milling), it consumes a lot of energy and manpower.

Parboiling is the process of partially boiling paddy inside the husk. It is a paddy pre-milling technique that originated in India [V. Subrahmanyam 1971]. Parboiling is a hydrothermal process that converts the crystalline structure of starch in paddy rice into an amorphous form [Rao, R.S.N. and Juliano, S.O. 1970]. Parboiling of paddy causes gelatinization of the starch during boiling, and during cooling, the amylose molecules of starch are re-associated with one another, forming a densely packed structure during cooling. The parboiling process makes the kernels harder and more glassy.

In the era of industrialization, developing countries due to technical constraints and high economic costs associated with the treatment process, face a significant problem of treating industrial waste before its disposal (Majumdar et al., 2007). Therefore, an effective management of industrial wastes to stop or at least reduce

waste generation through the development of waste recycling and reuse technologies (Jadhav and Hocheng, 2012). There have been many ecological disasters around the world in the past, and there is still a high probability of untreated industrial effluents may reach surrounding aquatic bodies and harm the organisms that inhabit them. Therefore, in the present investigation an attempt has been made to determine the physico-chemical properties of untreated parboiled rice mill effluents from the city of Miryalguda.

2. Materials and Methods

2.1. Study Area

Miryalguda is 1st Grade municipality in Nalgonda district of the Indian state of Telangana. It is located about 45 kilometres (27 mi) towards east from the district headquarters Nalgonda, 145 kilometres (88 mi) from the state capital Hyderabad. Miryalguda is located at 16.8667°N 79.5833°E. It has an average elevation of 105 meters (344 ft).

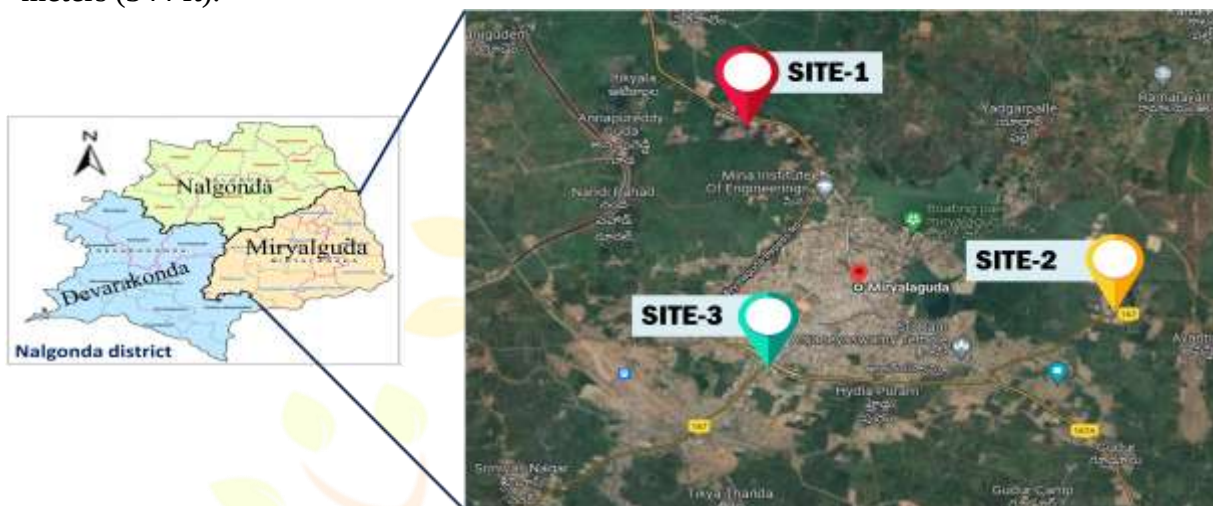


Figure1. Map of the study area (Miryalguda) showing the location of sampling sites (Site1-3)

Miryalguda, a rice milling hub in the state. It is famous for the paddy growth and it is listed among the top 5 paddy markets in Telangana. Water from Left canal of Nagarjuna Sagar makes Miryalguda and its surroundings green and commercially rich. The city has large number of parboiled rice mills across all of Asia but still in 4th position. This results in employment opportunities for thousands of people. Simultaneously there is huge pollution of air and water due to the dust, effluents coming from those rice mills.

2.2. Collection of Samples and Sampling Procedure:

The Parboiled rice mill effluent samples were collected from three different sites (as shown in fig.1) of the Miryalguda town of Nalgonda district, Telangana state in plastic water cans with monthly intervals during June 2019 to May 2020 and analyzed for physico-chemical characteristics. Various physico-chemical parameters of parboiled rice mill effluents were determined by using APHA 2017 Guidelines (APHA, AWWA, and WEF, 2017) as shown in the Table-1.

Table-1. Physico-Chemical Parameters and methods of parboiled rice mill effluents.

Sl.No	Parameter	Method	Method Ref.No
1	pH	Digital pH meter	Method 4500-H ⁺ B, APHA 23Rd EDN:2017
2	Electrical Conductivity	Digital Conductivity meter	Method 2510- B , APHA 23Rd EDN:2017
3	TDS	Digital Conductivity meter	Method 2540-B , APHA 23Rd EDN:2017
4	Total Hardness	EDTA Titrimetric Method	Method 2340-C , APHA 23Rd EDN:2017
5	Ca ⁺²	EDTA Titrimetric Method	Method 3500-Ca B , APHA 23Rd EDN:2017
6	Mg ⁺²	EDTA Titrimetric Method	Method 3500-Mg B , APHA 23Rd EDN:2017
7	Phosphates	Vanadomolybdophosphoric Acid Colorimetric method	Method 4500-P.C, APHA 23Rd EDN:2017
8	Chlorides	Argentometric Method	Method 4500-Cl-B , APHA 23Rd EDN:2017
9	BOD	5-day BOD test (BOD ₅)	Method 5210- B , APHA 23Rd EDN:2017
10	COD	Open reflux method	Method 5220 B , APHA 23Rd EDN:2017

3. Result and discussion.

Various physicochemical parameters for the effluents collected from Miryalguda areas are analyzed described below.

3.1. pH :

pH is a measure of the negative logarithm of hydrogen ion concentration in the effluent and gives an indication of acidity or alkalinity of the effluent. pH represents important characteristic of water and small changes in its level can disturb quality of water making it unsuitable for use. This factor is important because aquatic life such as most fish can only survive in a narrow pH range between roughly pH 6-9.

Table: 2. Monthly variations of pH values in three effluent sites (S-I, S-II, S-III)

Months	Control	Site-I	Site-II	Site-III	Mean
June	7.2	5.7	5.6	5.9	5.7
July	7.5	5.6	5.8	5.7	5.7
August	7.4	6	6.3	5.9	6.1
September	7.8	6.2	6.1	6	6.1
October	7.6	5.9	6.5	5.1	5.8
November	7.7	5.5	5.9	5.8	5.7
December	7.4	5	5.3	6.1	5.5
January	7.5	6.1	5.3	5.9	5.8
February	7.7	5	6	5.2	5.4
March	7.8	6.1	5.9	5.8	5.9
April	7.4	5.6	5.4	5.8	5.6
May	7.6	5.7	5.6	5.9	5.7
Mean± SD	7.55±0.18	5.7±0.4	5.81±0.38	5.76±0.3	5.76±0.21
Range	7.8-7.2	6.2-5	6.5-5.3	6.1-5.1	6.1-5.4

The pH values with the majority of samples are not within the allowed pH ranges specified by several health and pollution control authorities, such as WHO, ICMR, and BIS, i.e 6.5 to 8.5, at the three research locations. In year 2024-25 at Site-I, the pH range from 5-6.2, samples taken from Site-II ranged from 5.3-6.5 and Site-III ranges from 5.1-6.1. With minimum and maximum value of all the three sites during 2024-25 was 5 and 6.5 respectively (Table-2 & Figure-2).

The mean ± SD of pH value during 2024-25 was 5.7±0.4 in site I, 5.81±0.38 in site-II, 5.76±0.3 in site-III.

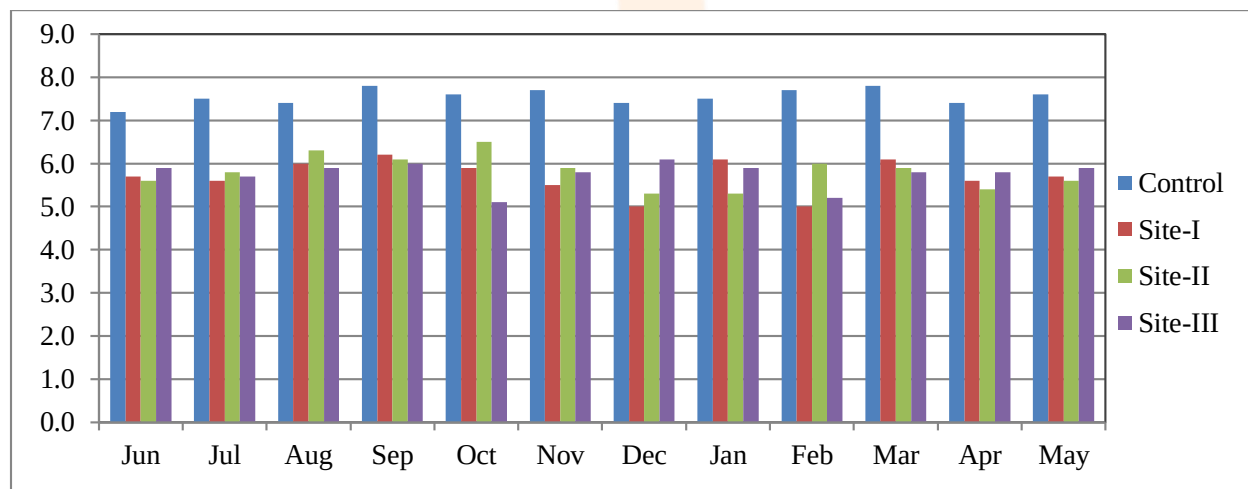


Figure: 2. Monthly variations of pH levels in three effluent sites (S-I,S-II,S-III)

3.2. Electrical Conductivity (EC)

Electrical conductivity is a measure of cations as well as anions in water. Increases in EC generally indicate increase in these inorganic species. Change in cationic and anionic concentration is very lethal for the aquatic life and human beings. Liver, kidney, digestive system and nervous systems are highly affected by these cations and anions. The collected samples show very much higher EC values, may be because of various unit operation in parboiled rice industry.

Table: 3.Monthly variations of EC values in three effluent sites (S-I,S-II,S-III) during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	1423	1522	1534	1524	1527
July	1435	1548	1524	1532	1535
August	1452	1545	1545	1529	1540
September	1460	1546	1529	1521	1532
October	1438	1552	1534	1543	1543
November	1429	1542	1522	1553	1539
December	1419	1538	1546	1548	1544
January	1437	1545	1551	1562	1553
February	1446	1562	1557	1558	1559
March	1458	1582	1571	1563	1572
April	1468	1567	1562	1571	1567
May	1471	1561	1582	1572	1572
Mean $\pm$ SD	1444.67 $\pm$ 17.26	1550.83 $\pm$ 15.48	1546.42 $\pm$ 18.97	1548 $\pm$ 18.09	1548.42 $\pm$ 15.68
Range	1471-1419	1582-1522	1582-1522	1572-1521	1572-1527

EC values for given Sites during year 2024-25 at Site-I ranged from 1522 to 1582, samples taken from Site-II ranged from 1522 to 1582 and Site-III ranged from 1521 to 1572 (Table-3 & Figure-3). The minimum Electrical Conductivity values were recorded at the site-3 i.e. 1521 and maximum at site-1 and 2 i.e. 1582 during 2024-25.

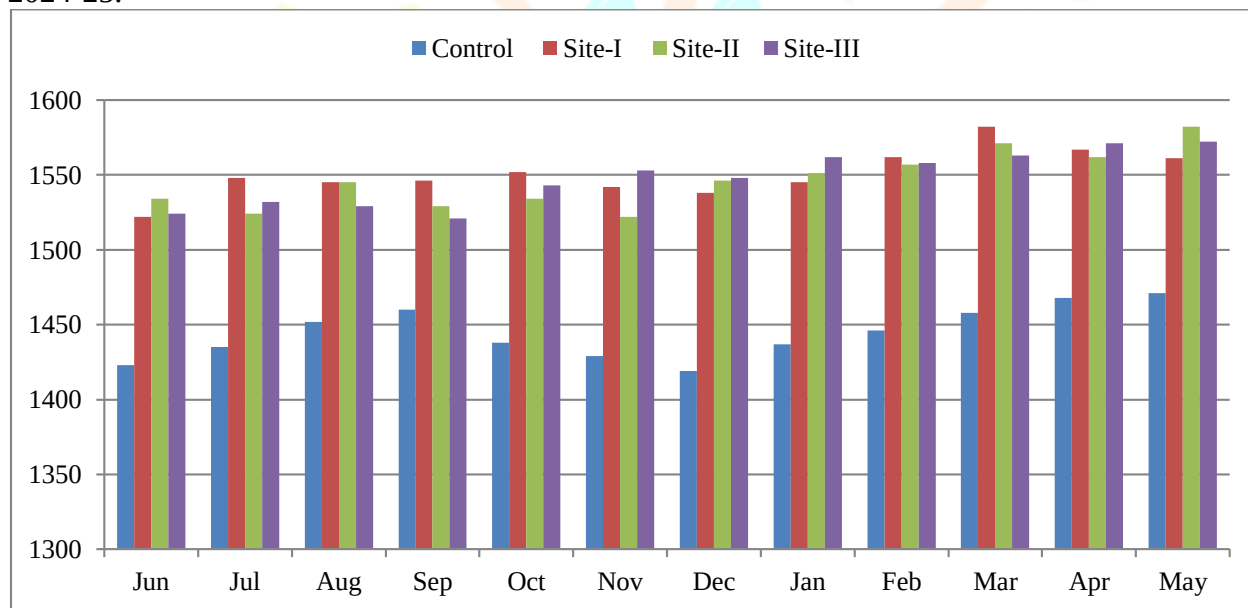


Figure: 3. Monthly variations of EC levels in three effluent sites (S-I, S-II,S-III)

The mean $\pm$ SD EC value during 2024-25 with overall mean of 1550.83 $\pm$ 15.48 in Site I, 1546.42 $\pm$ 18.97 in Site II and 1548 $\pm$ 18.09 in Site III (Table-3 & Figure-3). The values of electrical conductivity increased along with increasing concentration of effluents (Gagnetten *et al.*, 2007).

3.3. Chlorides (Cl⁻)

Chloride may be present in all natural waterways, including soil and rock formations, sea spray, and waste discharges. Sewage, like certain industrial effluents, has a high quantity of chloride.

Chlorides in Site-I ranged from 749 to 824 mg/L, samples taken from Site-II ranged from 758 to 838 mg/L and Site-III ranges from 738 to 827 mg/L (Table-4 & Figure-4) during year 2024-25

Table: 4.Monthly variations of Chloride levels in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	117	769	759	738	755
July	124	785	769	761	772
August	109	759	820	759	779
September	113	749	838	743	777
October	128	783	792	759	778
November	130	792	769	782	781
December	116	788	758	778	775
January	125	777	799	814	797
February	112	764	788	827	793
March	125	824	784	793	800
April	108	816	791	806	804
May	119	799	831	792	807
MEAN± SD	118.83±7.49	783.75±22.27	791.5±26.72	779.33±28.18	784.86±15.49
RANGE	130-108	824-749	838-758	827-738	807-755

The minimum chloride values were recorded at the site-3 i.e. 738 mg/l. and maximum at site-2 i.e. 838 mg/l during 2024-25. High chloride concentration is harmful for metallic pipes as well as for agriculture crops. Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high chloride may subject to laxative effects.

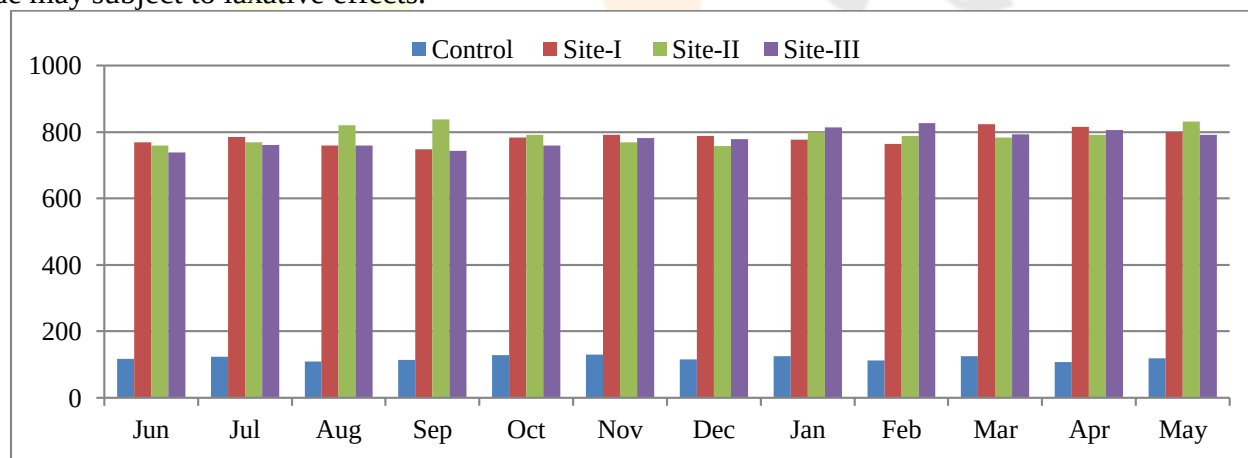


Figure: 4. Monthly variations of Chloride levels in three effluent sites (S-I,S-II,S-III)

The mean± SD of Chloride value during 2024-25 with overall mean of 783.75±22.27 in Site I, 791.5±26.72 in Site II and 779.33±28.18 in Site III (Table-4).

3.4. Biological Oxygen Demand (BOD)

Biological Oxygen Demand (BOD) represents the amount of oxygen used by the microorganism to decompose the organic material. Range of BOD values of effluents collected from the three sites i.e. Site-1, Site-2, Site-3 during 2024-25 were 2395-2698 mg/L. These values of BOD were higher the maximum desirable limit (30mg/L) of Central Pollution Control Board of India.

Table: 5. Monthly variations of BOD values in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	4	2576	2631	2485	2564
July	3	2587	2489	2546	2541
August	5	2499	2577	2511	2529
September	3	2510	2489	2489	2496
October	4	2483	2614	2574	2557
November	5	2485	2561	2596	2547
December	3	2395	2485	2578	2486
January	4	2635	2631	2465	2577
February	4	2489	2587	2544	2540
March	5	2578	2599	2487	2555
April	4	2511	2610	2611	2577
May	3	2698	2578	2531	2602
MEAN± SD	3.92±0.79	2537.17±81	2570.92±54.47	2534.75±48.13	2547.61±33.11
RANGE	5-3	2698-2395	2631-2485	2611-2465	2602-2486

The Site-I has a BOD value ranging from 2395-2698, while Site-II has a BOD value ranging from 2485-2631 and Site-III ranged from 2465-2611 mg/L (Table-5 & Figure-5). Minimum and maximum BOD levels during investigation period were 2395mg/L and 2698 mg/L.

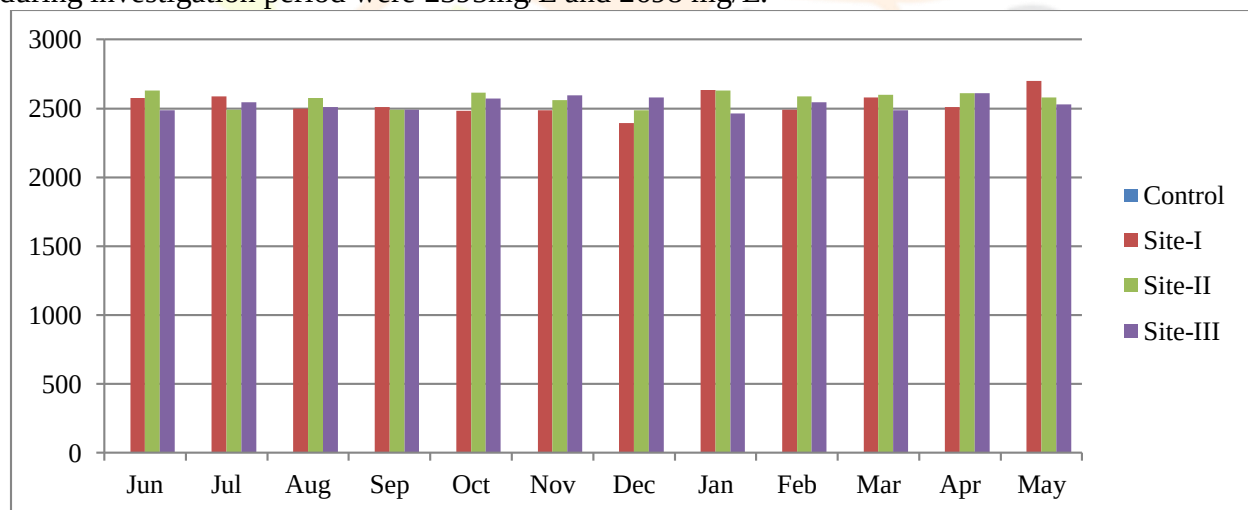


Figure: 5. Monthly variations of BOD levels in three effluent sites (S-I, S-II, S-III)

The mean± SD of BOD value during 2024-25 with overall mean of 2537.17±81 in Site I, 2570.92±54.47 in Site II and 2534.75±48.13 in Site III (Table-5).

3.5. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) represents the amount of oxygen required for oxidizing the all organic matters. The maximum permissible limit of COD recommended by Central Pollution Control Board of India is 250mg/L while the COD of effluents collected from different sites during 2024-25 ranged between 6402-7102 which were found much greater than standard values. These values are higher than the range of 75 to 145 mg/L and 595 to 800 mg/L for BOD and COD, respectively as reported by Singh *et al.*, (1996). These differences may be due to variations in manufacturing processes, production capacity and efficiency of treatment plants as well as sites of effluent collection.

Table: 6. Monthly variations of COD values in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	306	6521	6895	6712	6709
July	289	6638	6897	6548	6694
August	297	6548	6498	6402	6483
September	283	6553	6523	6785	6620
October	313	6658	6578	6784	6673
November	308	6645	6542	6785	6657
December	293	6687	6642	6600	6643
January	285	6489	6526	6478	6498
February	278	6589	6812	6452	6618
March	281	6635	6875	6771	6760
April	311	6710	7102	6988	6933
May	291	6812	7095	7013	6973
MEAN± SD	294.58±12.27	6623.75±90.2	6748.75±224.57	6693.17±199.94	6688.56±147.22
RANGE	313-278	6812-6489	7102-6498	7013-6402	6973-6483

COD values for given Sites during 2024-25 ranged from 6402 to 7102. In Site-I COD ranges from 6489 to 6812, samples taken from Site-II ranged from 6498 to 7102 and Site-III ranges from 6402 to 7013 mg/L (Table-6).

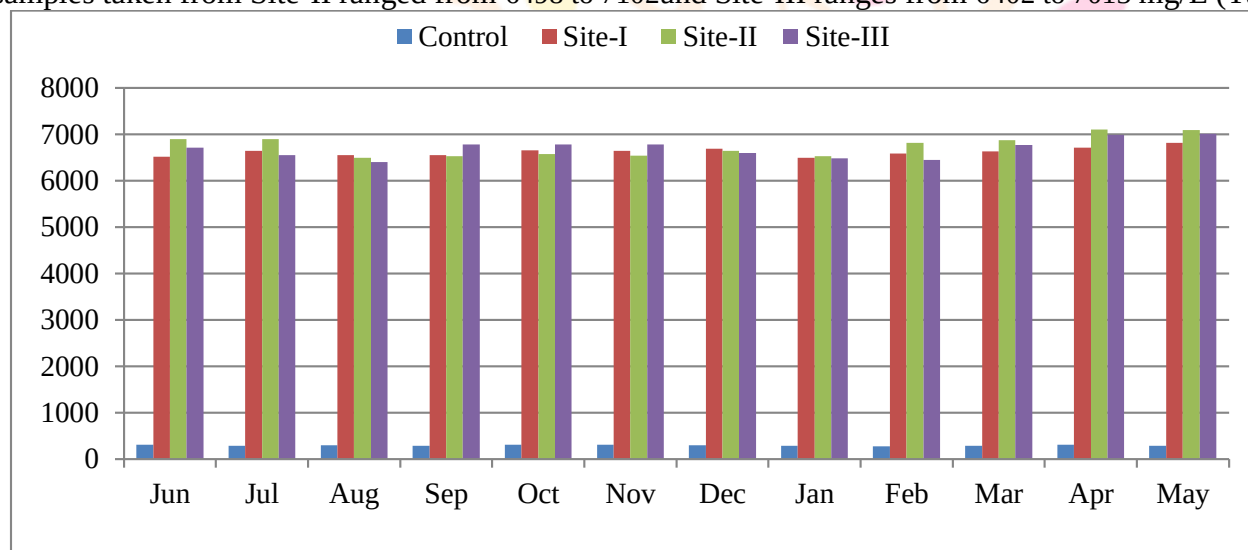


Figure: 6. Monthly variations of COD levels in three effluent sites (S-I,S-II,S-III)

With minimum and maximum value of COD during 2024-25 are 6402 and 7102. The mean± SD COD value during 2024-25 with overall mean of 6623.75±90.2 in Site I, 6748.75±224.57 in Site II and 6693.17±199.94 in Site III (Table-8). Samples from all the parboiled rice mills show very high BOD and COD value and therefore indicate the presence of organic carbon. This is a cause of concern since high organic carbon decrease the dissolve oxygen level and seriously affects aquatic life.

3.6. Total Hardness (TH)

Hardness is a measure of capacity of water to precipitate soap, contributed by presence of calcium, magnesium and presence of minerals. The hardness of both the untreated and treated samples was almost close to the permissible range.

Table: 7. Monthly variations of Total Hardness values in three effluent sites during 2024-25.

Months	Control	Site-I	Site-II	Site-III	Mean
June	358	527	536	541	535
July	346	533	527	526	529
August	367	534	529	537	533
September	367	511	534	519	521
October	351	518	519	524	520
November	374	540	528	537	535
December	354	528	547	529	535
January	352	539	546	528	538
February	362	540	534	534	536
March	348	547	547	524	539
April	329	531	536	548	538
May	348	539	533	544	539
MEAN± SD	354.67±12.01	532.25±10.15	534.67±8.64	532.58±8.99	533.17±6.44
RANGE	374-329	547-511	547-519	548-519	539-520

The total hardness in Site-I ranged from 511-547, samples taken from Site-II ranged from 519-547 and Site-III ranges from 519-548 mg/L (Table-7 & Figure-7). The minimum Total Hardness values were recorded at the site-1 i.e. 511 and maximum at site-3 i.e. 548 during 2024-25. The mean± SD total hardness value during 2024-25 with overall mean of 532.25±10.15 in Site I, 534.67± 8.64 in Site II and 532.58±8.99 in Site III (Table-7).

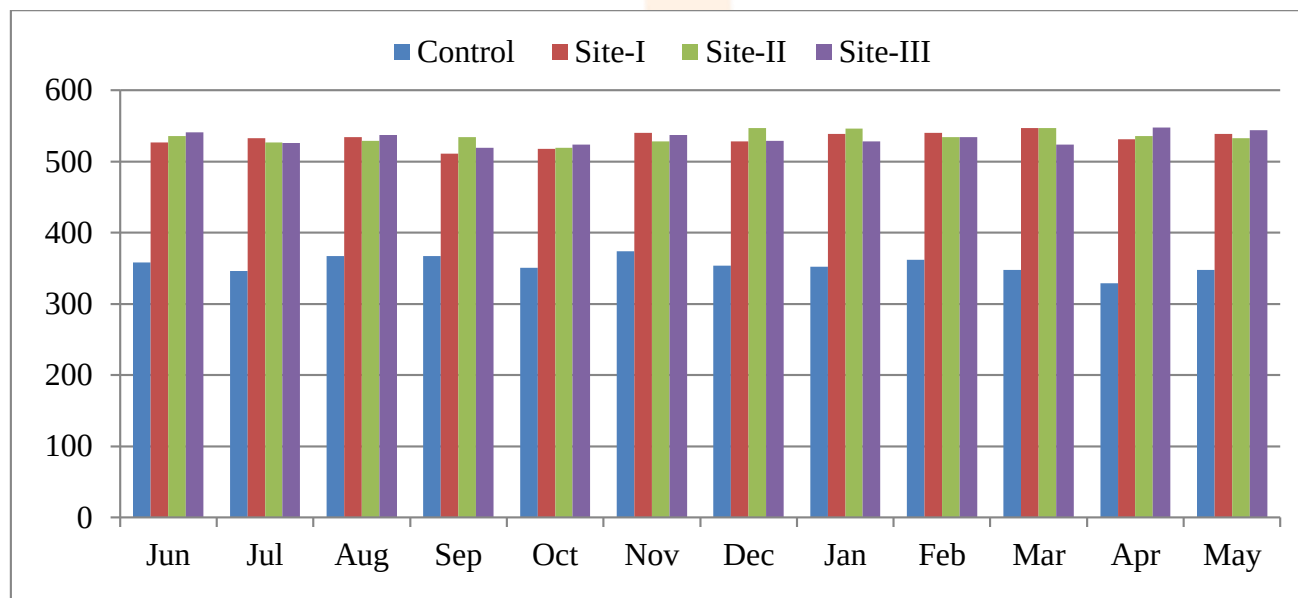


Figure: 7. Monthly variations of Total Hardness levels in three effluent sites (S-I, S-II, S-III)

3.7. Calcium (Ca^{+2})

The Calcium ranges in Site-I from 168 to 224 mg/L, while Site-II had a calcium of 166 to 256 mg/L and Site-III ranges from 166 to 201 in year 2018-19. (Table-8).

Table: 8 Monthly variations of Calcium levels in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	96	172	172	166	170
July	102	169	175	172	172
August	97	181	179	185	182
September	89	176	182	180	179
October	93	185	187	178	183
November	111	174	193	187	185
December	124	192	189	186	189
January	104	187	166	168	174
February	93	168	227	192	196
March	100	198	199	186	194
April	109	212	247	197	219
May	124	224	256	201	227
Mean± SD	103.5±11.56	186.5±17.52	197.67±29.66	183.17±10.9	189.11±17.79
Range	124-89	224-168	256-166	201-166	227-170

During 2024-25 the minimum Calcium values were recorded at the site-2 and 3 i.e. 166 and maximum at site-2 i.e. 256. The mean Calcium value during 2024-25 with overall mean of 186.5±17.52 in Site I, 197.67±29.66 in Site II and 183.17±10.9 in Site III (Table 8 & Figure-8).

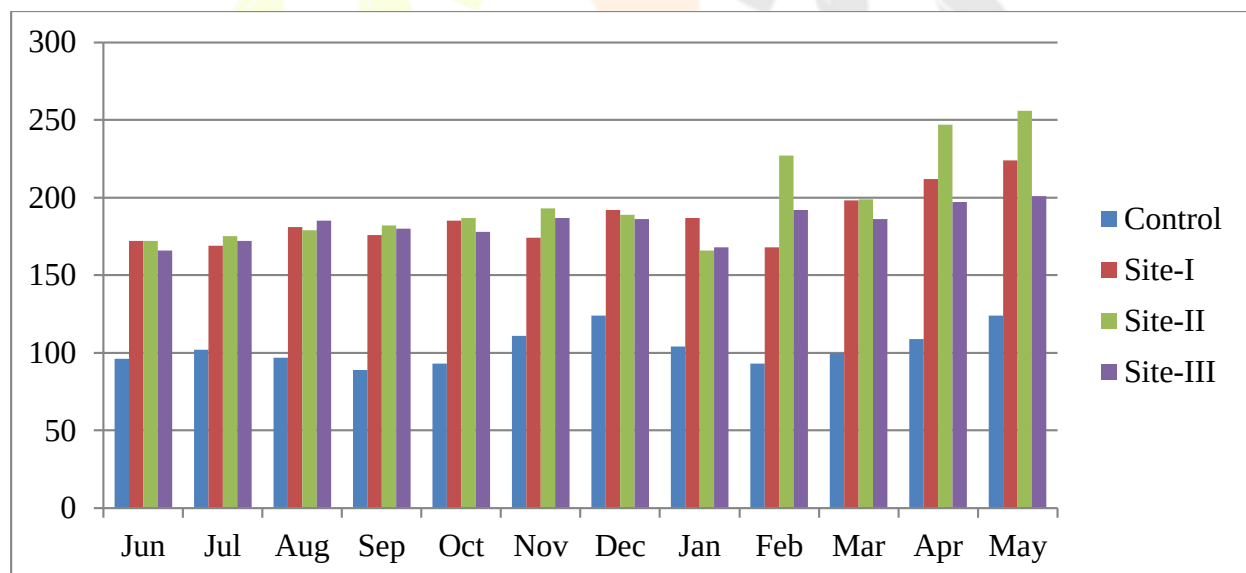


Figure: 8. Monthly variations of Calcium levels in three effluent sites (S-I,S-II,S-III)

Calcium is a micronutrient that is essential for the development of skeletal and bony structures in aquatic creatures that live in bodies of water.

3.8 . Magnesium (Mg^{+2})

Magnesium is a significant contributor to water hardness. Concentrations significant than 125ppm have cathartic and diuretic properties. Chemical procedures such as reverse osmosis, chemical softening, electro dialysis and ion exchange can be used to remove Mg^{+2} excesses.

Table: 9. Monthly variations of Magnesium levels in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	24	34	35	35	35
July	23	36	36	34	35
August	24	37	34	36	36
September	21	34	35	32	34
October	27	32	36	34	34
November	26	34	34	36	35
December	23	35	36	35	35
January	25	36	34	36	35
February	28	34	38	34	35
March	26	35	36	38	36
April	24	40	35	33	36
May	26	33	39	38	37
Mean± SD	24.75±1.96	35±2.09	35.67±1.56	35.08±1.83	35.25±0.89
Range	28-21	40-32	39-34	38-32	37-34

During investigation period at Site-I, the Magnesium ranges from 32 to 40, samples taken from Site-II ranged from 34 to 39 and Site-III ranges from 32 to 38 mg/L (Table-9 & Figure-9).

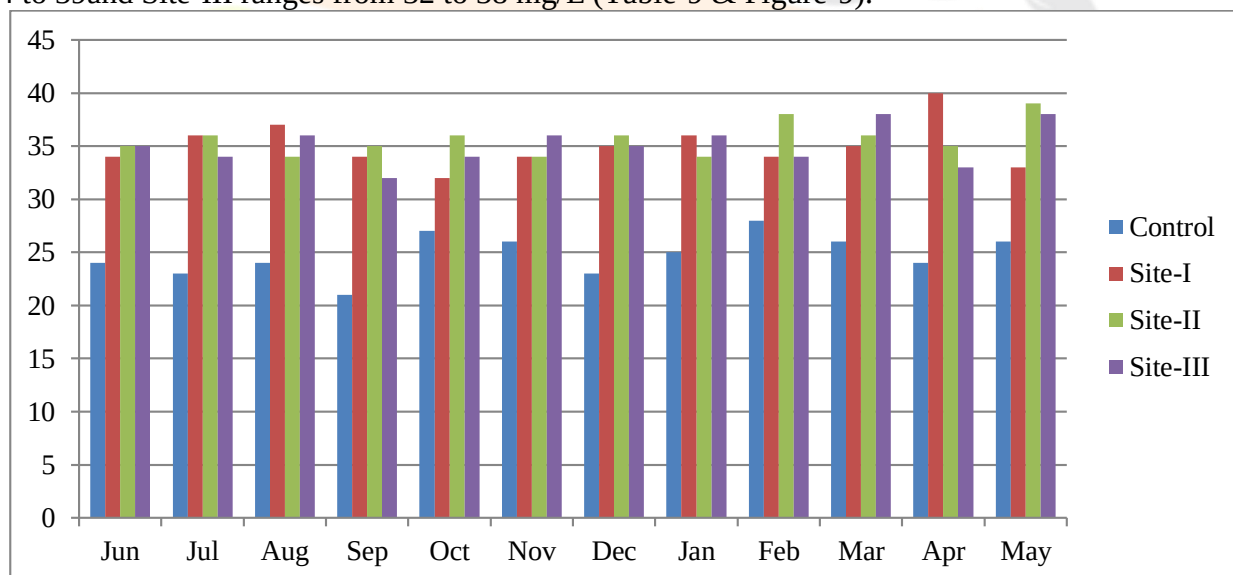


Figure: 9 . Monthly variations of Magnesium levels in three effluent sites (S-I, S-II,S-III)

The minimum Magnesium values were recorded at the site-1 and 3 i.e. 32 and maximum at site-1 i.e. 40 during the study. The mean $\pm$ SD Magnesium value during 2024-25 with overall mean of 35 ± 2.09 in Site I, 35.67 ± 1.56 in Site II and 35.08 ± 1.83 in Site III (Table-9).

3.9 .Total Dissolved Solids (TDS)

TDS is a measurement of inorganic salts, organic matter and other dissolved materials in water. The important contributors for the TDS values are presence of Na^+ , Ca^{2+} , Mg^{2+} , CO_3^{2-} , SO_4^{2-} , Cl^- etc. in water. Change in concentration of these ionic species in water alters the population of different types of species like microorganisms, algae and fishes. TDS values obtain in the collected samples are dangerously higher than the standard values of water quality; this is a clear indication of presence of various organic as well as inorganic substances in Parboiled rice mill effluent.

Table: 10.Monthly variations of TDS in three effluent sites during 2024-25.

Months	Control	Site-I	Site-II	Site-III	Mean
June	928	1590	1482	1679	1584
July	937	1578	1625	1502	1568
August	952	1581	1621	1637	1613
September	964	1598	1657	1578	1611
October	957	1487	1459	1610	1519
November	961	1678	1522	1487	1562
December	964	1644	1580	1587	1604
January	938	1666	1745	1582	1664
February	935	1490	1657	1648	1598
March	929	1700	1732	1655	1696
April	949	1599	1728	1872	1733
May	958	1812	1782	1657	1750
Mean± SD	947.67±13.58	1618.58±89.95	1632.5±105.8	1624.5±98.36	1625.19±71.08
Range	964-928	1812-1487	1782-1459	1872-1487	1750-1519

During the year 2024-25 at Site-I, the Total Dissolved Solids ranges from 1487 to 1812, samples taken from Site-II ranged from 1459 to 1782 and Site-III ranges from 1487 to 1872 mg/L (Table-10 & Figure-10).

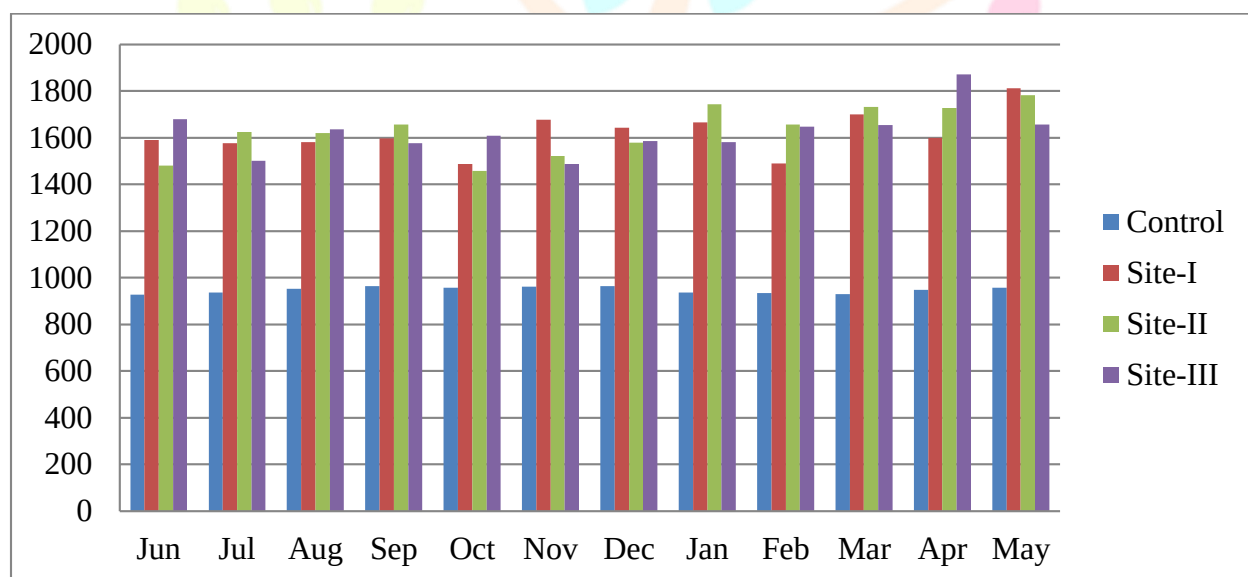


Figure: 10. Monthly variations of TDS levels in three effluent sites (S-I,S-II,S-III)

The minimum Total Dissolved Solids were recorded at the site-2 i.e.1459 and maximum at site-3 i.e. 1872 during 2024-25.The mean Total Dissolved Solids value during 2024-25 with overall mean of 1618.58± 89.95 in Site I, 1632.5± 105.8 in Site II and 1624.5± 98.36 in Site III (Table-10).

3.10. Phosphates

Phosphates in natural water typically range between 0.005 mg/l and 0.020 mg/l. Phosphate values observed to be higher in all the samples collected. In the present study, its concentration ranges from 22 mg/l to 34 mg/l. The study area highest result for phosphate is shown in sample No. 3 [34 (mg/l)]. Phosphate levels in groundwater samples may have increased because agriculture is the main industry in the research area and fertilizer applications containing phosphate is frequent [Domagalski, J. et al. 2012].

Table: 11. Monthly variations of Phosphate levels in three effluent sites during 2024-25

Months	Control	Site-I	Site-II	Site-III	Mean
June	0.29	27	30	27	28
July	0.48	30	28	24	27
August	0.41	29	27	28	28
September	0.38	29	30	23	27
October	0.52	27	28	22	26
November	0.48	28	28	32	29
December	0.41	30	26	30	29
January	0.31	29	27	29	28
February	0.45	31	30	25	29
March	0.57	30	29	30	30
April	0.68	31	31	31	31
May	0.54	32	30	34	32
Mean± SD	0.46±0.11	29.42±1.56	28.67±1.56	27.92±3.78	28.67±1.69
Range	0.68-0.29	32-27	31-26	34-22	32-26

During the year 2024-25 at Site-I, the phosphates ranges from 27-32, samples taken from Site-II ranged from 26-31 and Site-III ranges from 22 to 34 mg/L (Table-11& Figure-11).

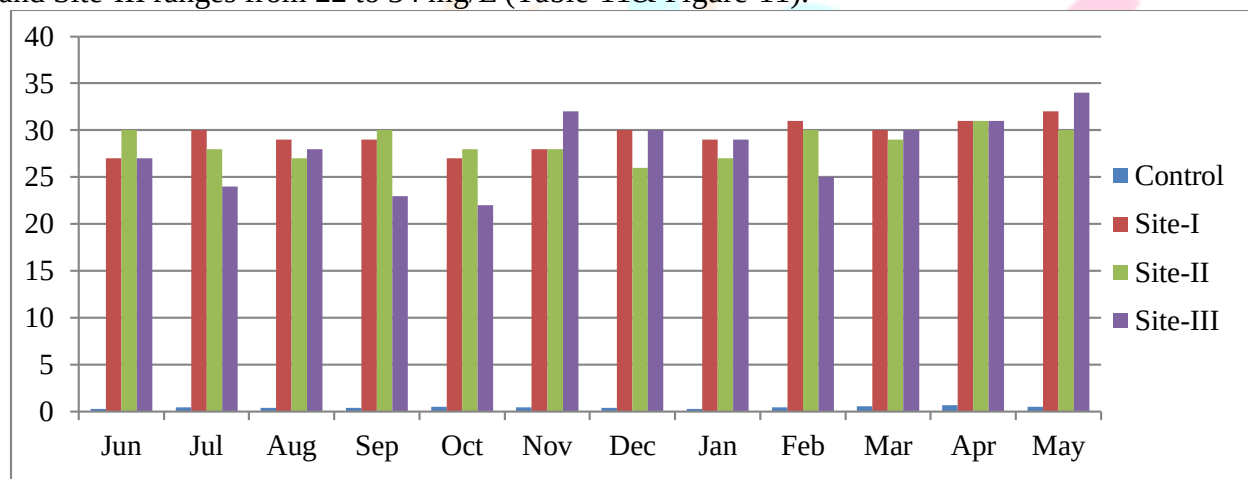


Figure: 11. Monthly variations of Phosphate levels in three effluent sites (S-I,S-II,S-III)

The minimum Phosphates were recorded at the site-3 i.e.22 and maximum at site-3 i.e. 34 during 2024-25. The mean phosphate value during 2024-25 with overall mean of 29.42±1.56 in Site I, 28.67±1.56 in Site II and 27.92±3.78 in Site III (Table-11).

4. Conclusion

The physico-chemical characteristics such as pH, Electrical conductivity, BOD,COD, Chlorides, Total hardness, Calcium, Magnesium, TDS and Phosphates were relatively high in the untreated parboiled rice mill effluent samples. All industries in India are mandated by law to properly treat their effluents before discharging them. However, aquatic organisms could suffer greatly from improper management of untreated effluents.

A continuous pollution monitoring system for the parboiled rice mill effluents is required, according to the study. In addition to this, provincial governments and NGO's in India should develop new policies to inspect and ensure that discharge effluents adhere to established standards. The study also found that the discharge of untreated parboiled rice mill effluents may have a negative effect on the ecosystem. Therefore, it is crucial to treat the effluents before releasing them into the environment.

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