

Underground Water Quality in Major Paddy Plants Growing Area of Mayiladuthurai Taluk of Nagapattinam District in Tamil Nadu – India

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ABSTRACT

Water is essential for agriculture. Most of the farmers depending upon the ground water for irrigation purpose, but now a days the underground water is going to towards very deep down level. Because our environment affected by water drought, pollution and lack of rain falls. It will be creating negative effects to cultivation .In this present study is to assess the underground water quality in Mayiladuthurai Taluk of Nagapattinam District in Tamil Nadu. Totally 30 underground water samples were collected, which covers 10 Revenue villages in Mayiladuthurai Taluk, 3 samples from each Revenue village and analyzed all the physico - chemical parameters such as pH, EC, Ca, Na, K, SO₄, Cl, Mg , CO₃, and HCO₃ and the water quality index SAR, RSC, Geo-chemical types, classification were determined by standard methods, standard calculation and by using standard instruments. Then the irrigation water quality results were compared with standard values Recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR). The proposed work is very essential not only for crop production but also to maintain soil fertility, to maintain hazardous free environment and to enhance the living standard and in turn to uplift our Agriculturist.

Keywords: Irrigation Water, Mayiladuthurai Taluk, Nagapattinam District, Tamil Nadu

Introduction

Ground water plays an important vital in agriculture, for both watering of crops and for irrigation of dry season crops. It is estimated that about 45% of irrigation water requirement is met from ground water sources. The quality of ground water is changing from place to place along with the depth. It also varies with seasonal changes and is primarily governed by the extent and composition of dissolved solids present in it. In most of the instances, the extraction of excessive quantities of ground water has resulted in drying up of wells, damaged ecosystems, land subsidence, salt-water intrusion and depletion of the resource. The concentration and composition of dissolved salts in water decides its suitability for irrigation, degradation of ground water quality of the aquifers causing sea water interference into the coastal aquifers ^[1]. Water samples analyzed by standard methods ^[2-6]. Total concentrations of soluble salts, relative quantity of sodium to other cations and the bicarbonate concentration related to the concentration of calcium plus magnesium are important characteristics determining the quality of irrigation water. Salinity of irrigation water may limit the choice of crops that can be grown. The most influential water quality guideline on crop productivity is the water salinity hazard as measured by electrical conductivity.^[7]

Study Area

The study area is Mayiladuthurai Taluk of Nagapattinam district coastal region in the southern Tamilnadu State located in the coastal region of Bay of Bengal 11.0290373 Latitude and 79.8506815 Longitude. This taluk is spread over in 27,726 hectares of Agriculture land. Fig.1 shows the study area.

Materials and Methods

Irrigation water samples were collected randomly in a systematic manner covering major rice growing area in Mayiladuthurai taluk of Nagapattinam district. A total 30 samples were collected from directly bore wells in clean plastic cans of 1 liter capacity. The bottles are tagged individually for sufficient information similar to date, location, deepness of well. The results of the average mean value of irrigation water quality parameters are shown in Table.10. The percentage of irrigation water quality parameters are shown in Table.11. Quality of irrigation water analyzed in the laboratory determined many parameters such as pH, EC, Ca, Na ,K, SO₄, Cl, Mg , CO₃, and HCO₃ are determined by standard methods and by using standard instruments. Then the irrigation water quality results are compared with standard values Recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR).

Important water quality ratings

Important water quality ratings that merit consideration are detailed below, from table (1 to 8). These ratings could be used as guidelines when recommendations are given.

Sodium Absorption Ratio (SAR)

The ratio of sodium contents to that of calcium and magnesium in the water is called Sodium Absorption Ratio. Sodium Absorption Ratio also denotes sodium hazard (table.7).

$$SAR = \frac{Na^{2+}}{\sqrt{Ca^{2+} + Mg^{2+}}} / 2$$

Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate indicates bicarbonate hazard. It is determined by the proportion of carbonate ions to that of calcium and magnesium ions (table.8)

$$RSC \text{ (Meq/lit)} = (CO_3^{2+} + HCO_3^{2+}) - (Ca^{2+} + Mg^{2+})$$

The increased Residual Sodium Carbonate value leads to alkali formation because of the precipitation of calcium and magnesium carbonate/ bicarbonate or sodium and bicarbonate

Geo Chemical Type

Calcium bicarbonate and calcium sulphate waters contain the lowest conductance. Sodium chloride water has the highest conductance. When calcium and magnesium more than half of the total cations it is considered calcium/ magnesium type^[7]. When sodium and potassium is more than half of the total cations, the water is considered sodium type, if bicarbonate, carbonate is than 50% of the total anions, it is considered bicarbonate type. The content of chloride plus sulphate exceeds 50% of the total anions it is considered chloride type. Problems associated with some Geo chemical types of water. Geo chemical type refers to predominate soluble salt present in the irrigation water. The wide Geo chemical types are chloride water, sulphate water, bicarbonate water. Associating with different cations, the Geo chemical type varies. Magnesium content is the important in determining the quality of irrigation water, sodium is another essential factor to study sodium hazard. The high percentage of sodium water stunts the plant growth, sodium react with soil to decrease its permeability^[8]. Sodium percent in water is a parameter computed to evaluate the suitability for irrigation^[9]. Excess sodium water develop the unwanted effects of changing soil properties and reducing soil permeability^[10], the irrigation water tends to enter into cation-exchange reactions in soil can be indicated by the sodium absorption ratio^[11]. The irrigation water status of mayiladuthurai taluk were given figure 2 to 6.

Result and Discussion

Assess the 30 irrigation water samples collected from 10 revenue villages in Mayiladuthurai taluk by collecting 3 water samples per village revealed that water analysis parameter in Mayiladuthurai Taluk, water samples with mean status of the C₁ S₁ R₁ classification (table.10 and fig.4 to 6).

The irrigation water status of Mayiladuthurai taluk is given in Table 10 to 11 and, fig.2 to 6. Based on the electrical conductivity classification, 53.3 % of villages covers under C₁ classification, 30 % of villages covers under C₂ classification, and C₃ classification is 16.7 %. In Mayiladuthurai taluk, 53.3 % of villages cover under C₁ classification due to basin area. Based on Sodium Absorption Ratio classification, 100 % of villages cover under S₁ classification. S₂ and S₃ classifications are not found. In 100 % villages covers S₁ classification due to non-saline water. Based on Residual Sodium Carbonate classification, 96.6 % villages cover under R₁ classification, 3.3 % for R₂ and R₃ are not found.

Conclusion

The present study assesses the water quality status of Mayiladuthurai taluk exposed that they have become a significant trouble (Yield limiting factor) in Mayiladuthurai taluk. Hence the suggestion for different type of water for better yield. Sodium and chloride such water could be improved by gypsum application. Chemical amendments are aimed at to introduce favorable cationic ratios. If water contains high sodium and magnesium bicarbonates, gypsum can be added to irrigation water. Soils irrigated with poor quality water are low in fertility particularly nitrogen. Nitrogen response in good when is applied along with manure, under saline and alkaline soils, should be avoided due to nitrogen loss.

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11. V. Sing and C.C.P. Singh. Asian J. Chem., 18, 2813 (2004). Table-1 : Irrigation water characteristics in winter season.

(Tables & Figures)

Table. 1 Water Quality Based on EC,SAR,RSC

Water Quality	EC (dsm ⁻¹)	SAR (Meq/lit)	RSC (Meq/lit)
Good	Less than 2.0	Less than 10.0	Nil
Marginal water	2-4	Less than 10.0	Less than 2.5
Saline water	More than 4.0	Less than 10.0	Nil
Sodic water	Less than 4.0	More than 10.0	Usually more than 2.5

Table. 2 Water Quality Based on Sodium

Low sodium water	Could be used in almost all soils.
Medium.sodium water	Considerable sodium hazard in high clay soils and low organic matter under low discharge conditions unless gypsum is present in the soils.
High sodium water	Sodium hazard is significant in non-gypsiferous soils. Good drainage, good discharge and organic matter are wanted. Chemical amendments may be used for transferable sodium replacement expect for high salinity water.

Table. 3 Water Quality Based on Electrical Conductivity

Low salinity water	0-250 (dsm ⁻¹)	Used for most crops on most Soils with little possibility of Salinity some leaching is required.
Moderate salinity water	250-750 (dsm ⁻¹)	All the crops except extremely salt sensitive crops, when grown on soils of high to medium permeability. Leaching precaution and moderate salt tolerant crops.
Medium to high salinity	750-2250 (dsm ⁻¹)	Should be used only on soils of moderate to good permeability. Regular leaching and plants with moderate to good tolerance to salinity.
High salinity water	2250-6000 (dsm ⁻¹)	To be used only on soils of good permeability with regular leaching. Plants with high tolerance.
Excess salinity water	More than 6000 (dsm ⁻¹)	Should not be used.

Table. 4&5 Salinity classification

Low to moderate salinity	0-750	NaCl -1	MgCl ₂ - 1
Medium to high salinity	750-2250	NaCl -2	MgCl ₂ -2
High salinity	2250-4000	NaCl -3	MgCl ₂ -3
Very high salinity	4000-6000 and above	NaCl -4	MgCl ₂ -4

Low to medium	0-2250	CaCl ₂ .1
High	2250-4000	CaCl ₂ .2
Very high	4000-6000	CaCl ₂ .3
Excessive	More than 6000	CaCl ₂ .4

Table. 6 Classification of irrigation water based on Electrical Conductivity

Class	E.C (dsm ⁻¹)	Salinity status	Suitability
C ₁	0.0-1.0	Low salinity water	Excellent
C ₂	1.01-2.0	Medium salinity water	Good
C ₃	2.01-4.0	Salinity water	Doubtful
C ₄	4.01-6.0	High salinity water	Injurious
C ₅	>6.0	Very high salinity water	Unsuitable

Table.7 Classification of irrigation water based on Sodium Absorption Ratio

Class	SAR	Suitability
S1	< 10	Safe
S2	10.01-20.0	Moderate
S3	>20.0	Unsafe

Table. 8 Classification of irrigation water based on Residual Sodium Carbonate

Class	RSC (Meq/lit)	Suitability
R1	< 1.25	Safe
R2	1.26-2.50	Moderate
R3	>2.50	Unsafe

Table No. 9- Irrigation Water Quality Parameters of Mayiladuthurai Taluk of Nagapattinam District.

No	Villages	No of sample	pH	EC(ds m ⁻¹)	ANIONS (meq/lit)				CATIONS (meq/lit)							RSC	SAR	Type	Class
					CO ₃	HCO ₃	Cl	SO ₄	Total	Ca	Mg	Na	K	Total					
1	Maharajapuram	3	7.9	0.66	0.5	3.6	2.5	-	15.16	2.2	1.3	3.0	0.14	6.64	0.6	2.3	NaHCO ₃	C ₁ S ₁ R ₁	
			8.0	0.69	0.6	3.4	2.9	-	15.59	1.8	1.7	3.2	0.19	6.89	0.5	2.4	NaHCO ₃	C ₁ S ₁ R ₁	
			8.1	1.26	0.4	7.9	4.3	-	21.96	2.8	3.2	6.5	0.18	12.68	2.3	3.75	NaHCO ₃	C ₂ S ₁ R ₁	
2	Ponnur	3	7.6	2.5	-	5.7	19.3	-	35.1	6.1	8.2	10.39	0.27	24.96	-	3.89	NaCl	C ₃ S ₁ R ₁	
			7.8	2.8	0.2	5.7	22.1	-	38.6	7.4	9.1	11.24	0.29	28.03	-	3.91	NaCl	C ₃ S ₁ R ₁	
			7.9	1.6	0.2	7.5	8.3	-	25.5	4.9	3.7	7.15	0.23	15.98	-	3.45	NaCl	C ₂ S ₁ R ₁	
3	Pondur	3	7.9	0.86	0.2	6.2	0.2	-	15.36	1.5	3.7	3.24	0.2	8.64	1.2	2.01	Mg HCO ₃	C ₁ S ₁ R ₁	
			7.2	2.5	-	11.2	13.6	0.2	34.7	6.7	11.9	6.27	0.16	25.03	-	2.06	MgCl ₂	C ₃ S ₁ R ₁	
			8.0	0.72	0.2	4.2	2.8	-	15.92	2.0	2.1	2.9	0.2	7.2	0.3	0.49	NaHCO ₃	C ₁ S ₁ R ₁	
4	Thirumanglam	3	8.1	0.69	0.2	4.0	2.7	-	15.69	1.4	2.4	2.91	0.19	6.9	0.4	0.47	NaHCO ₃	C ₁ S ₁ R ₁	
			7.7	0.61	0.2	3.1	2.8	-	14.41	1.4	1.9	2.61	0.19	6.1	-	0.49	NaHCO ₃	C ₁ S ₁ R ₁	
			8.0	1.38	1.0	5.2	7.6	-	23.18	3.7	2.9	6.9	0.30	13.8	-	0.26	NaCl	C ₂ S ₁ R ₁	
5	Kali	3	6.8	0.25	-	1.7	0.8	-	9.55	1.4	0.8	0.17	0.15	2.52	-	0.16	Ca HCO ₃	C ₁ S ₁ R ₁	
			7.4	0.66	0.2	4.1	2.3	-	14.66	2.1	1.5	2.77	0.19	6.56	0.7	2.01	NaHCO ₃	C ₁ S ₁ R ₁	
			6.7	0.74	-	2.3	5.1	-	14.84	2.7	1.5	3.0	0.2	7.4	-	2.07	NaCl	C ₁ S ₁ R ₁	
6	Kadalangudi	3	7.0	0.83	0.4	4.1	3.8	-	16.13	3.2	1.9	3.1	0.1	8.3	-	1.94	Ca HCO ₃	C ₁ S ₁ R ₁	
			7.0	0.53	-	2.6	2.7	-	12.83	1.2	2.8	1.2	0.1	5.3	-	0.85	MgCl ₂	C ₁ S ₁ R ₁	
			5.9	0.99	-	5.2	4.7	-	16.79	3.2	4.1	2.5	0.16	9.96	-	1.31	Mg HCO ₃	C ₁ S ₁ R ₁	
7	Athur	3	7.1	0.87	-	3.7	5.0	-	16.67	2.9	2.5	3.1	0.17	8.67	-	1.89	NaCl	C ₁ S ₁ R ₁	
			7.4	1.32	0.2	6.9	5.9	0.2	21.92	3.8	4.5	4.69	0.21	13.2	-	2.31	NaHCO ₃	C ₂ S ₁ R ₁	
			7.1	1.60	-	8.7	7.1	0.2	24.7	3.6	4.6	7.57	0.16	15.93	-	3.74	NaHCO ₃	C ₂ S ₁ R ₁	
8	Manalmedu	3	7.5	1.93	-	6.4	12.7	0.2	28.73	6.5	6.6	6.03	0.16	19.29	-	2.36	MgCl ₂	C ₂ S ₁ R ₁	
			7.4	1.82	-	6.6	11.4	0.2	27.42	5.8	7.0	5.14	0.31	18.25	-	2.04	MgCl ₂	C ₂ S ₁ R ₁	
			7.2	0.76	-	5.4	2.2	-	15.56	2.1	3.0	2.34	0.23	7.67	0.3	1.47	Mg HCO ₃	C ₁ S ₁ R ₁	
9	Pattavarthi	3	8.0	1.08	0.7	6.6	3.5	-	19.88	2.2	2.6	5.8	0.2	10.8	2.5	3.74	NaHCO ₃	C ₂ S ₁ R ₂	
			6.5	0.82	-	4.8	3.4	-	15.52	3.0	1.5	3.56	0.18	8.24	0.3	2.37	NaHCO ₃	C ₁ S ₁ R ₁	
			7.3	0.63	-	4.1	2.2	-	14.23	1.8	2.0	2.29	0.16	6.25	0.3	1.67	NaHCO ₃	C ₁ S ₁ R ₁	
10	Thalainayur	3	7.2	2.3	-	7.2	15.6	0.2	32.5	7.5	7.2	8.0	0.29	22.99	-	2.95	NaCl	C ₃ S ₁ R ₁	
			7.3	2.6	-	7.6	18.2	0.3	36	7.8	9.1	8.87	0.27	26.04	-	3.05	MgCl ₂	C ₃ S ₁ R ₁	
			7.3	1.45	-	8.4	6.1	-	23.25	3.0	6.6	4.72	0.21	14.53	-	2.16	Mg HCO ₃	C ₂ S ₁ R ₁	

Table.10 Averagemean value of irrigation water quality parameters of mayiladuthurai taluk in nagapattinam district.

Sl.No	NAME OF THE TALUK	pH	EC(ds m ⁻¹)	ANIONS (meq/lit)					CATIONS (meq/lit)					RSC	SAR	Type	Class
				CO ₃	HCO ₃	Cl	SO ₄	Total	Ca	Mg	Na	K	Total				
1	MAYILADUTHURAI TALUK	7.4	1.24	0.3	5.47	6.72	0.2	21.07	3.5	4.0	4.70	0.19	12.49	0.8	2.11	NaC1	C ₁ S ₁ R ₁

Table.11 Percentage of Irrigation Water Quality Parameters of Mayiladuthurai Taluk in Nagapattinam District.

Sl.No	NAME OF THE TALUK	NaHCO ₃	MgHCO ₃	CaHCO ₃	NaCl	MgCl ₂	CaCl ₂	Cl	C2	C3	S1	S2	S3	R1	R2	R3
1	MAYILADUTHURAI TALUK	40.0	13.3	6.6	23.3	16.6	-	53.3	30.0	16.7	100	-	-	96.6	3.3	-

**Fig.1. Location Map
Mayiladuthurai Taluk in Nagapattinam District**

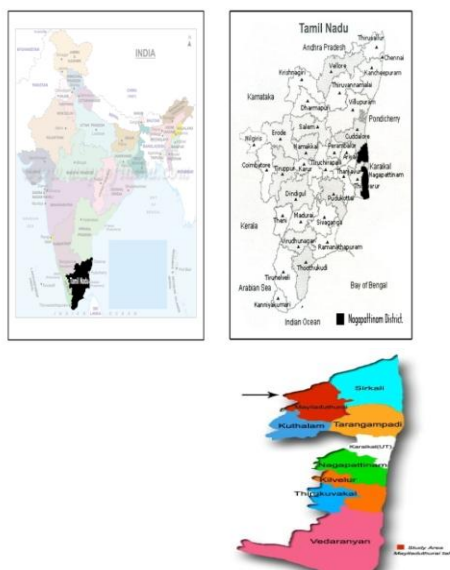


Figure .2 pH Status of Ten Revenue Villages of Mayiladuthurai Taluk

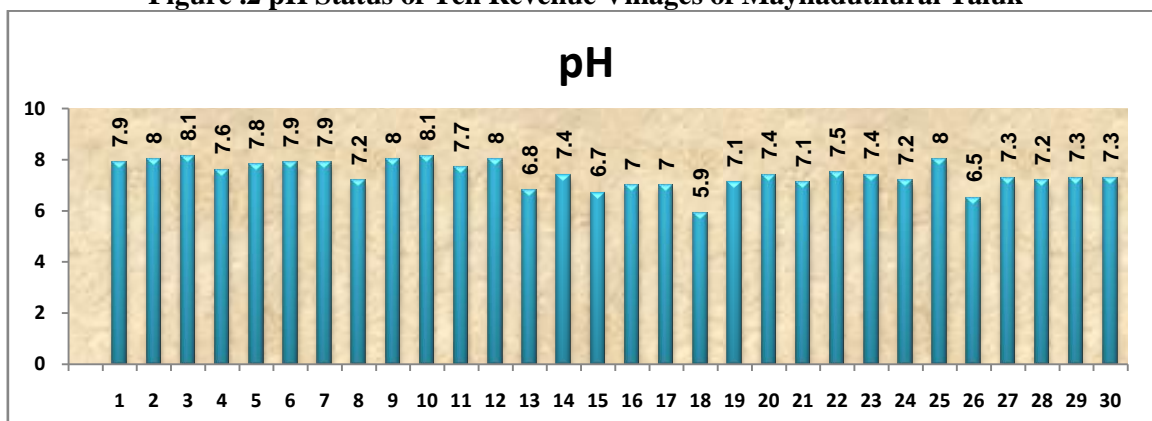
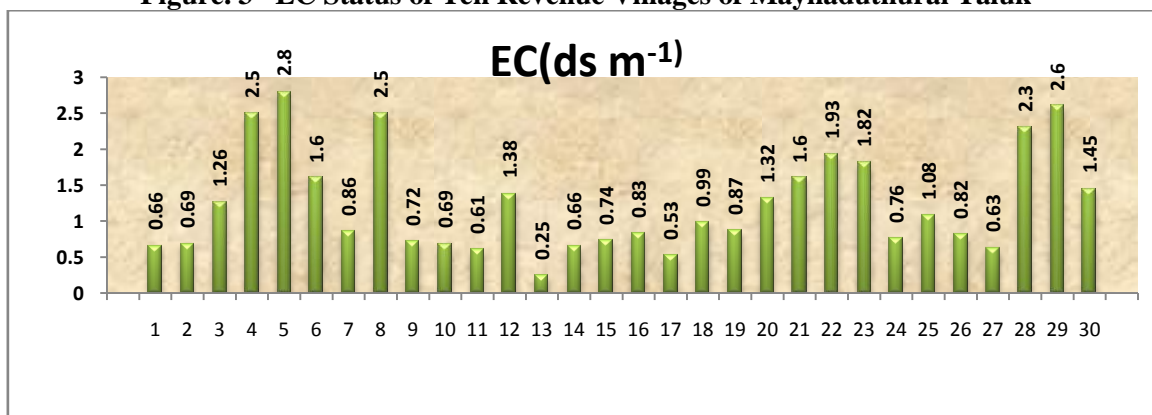


Figure. 3 EC Status of Ten Revenue Villages of Mayiladuthurai Taluk



IRRIGATION WATER STATUS OF MAYILADUTHURAI TALUK

Figure. 4 Electrical Conductivity Rating

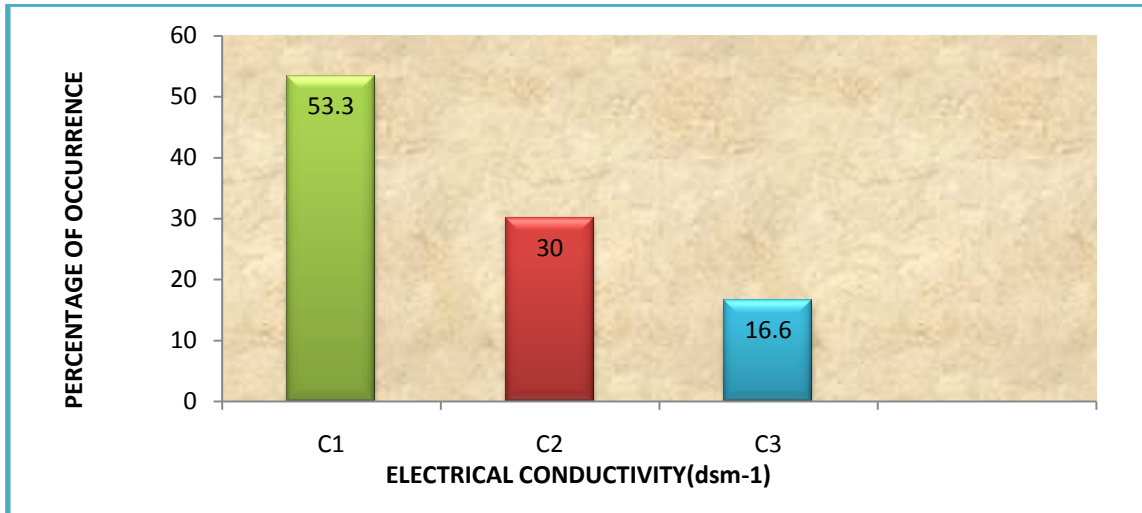


Figure. 5 Residual Sodium Carbonate Rating

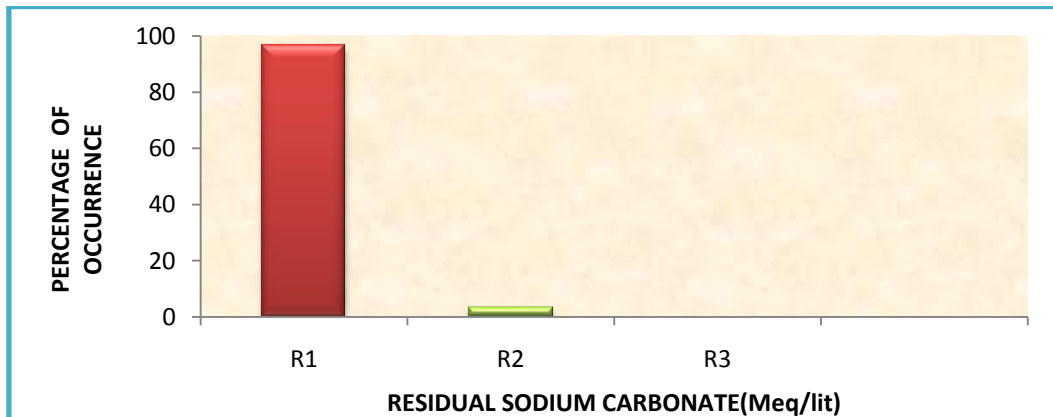


Figure. 6 Sodium Absorption Ratio

