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ORIGINAL ARTICLE

Physico- Chemical Study of Effluents from some Rubber Industries Situated at Nagercoil, Tamil Nadu, India

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ABSTRACT
In the present study effluents were collected from four rubber industries. The physical parameters like pH, electrical conductivity and chemical parameters like carbonate, bicarbonate, chloride, sulphate, calcium, magnesium, sodium and potassium were calculated. The irrigation quality of these effluents was calculated by using sodium absorption ratio. A comparative study was carried out between gloves producing industry and latex concentrate producing industry and found that effluents from latex concentrate producing industry was more polluted than gloves producing industry.
Keywords: *Heavea Brasiliensis, effluents, gloves, latex concentrate*

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INTRODUCTION

Hevea brasiliensis, a forest tree, is one of the most domesticated crop species in the world. and is the major commercial source of natural rubber. In India rubber cultivation is mainly concentrated in Kerala, Kanyakumari district of Tamil Nadu, Karnataka, North Eastern region, Andaman and Nicobar Islands, Goa and Maharashtra. The present investigation is the physico-chemical study of effluents from four rubber industries situated at Nagercoil. Increased activities of rubber processing industries usually generate large quantities of effluent with high concentrations of organic nutrient. Rakkoed *et al.* [10]. An average of 45,000L of effluent is discharged from a single 20 – 30 metric ton of rubber per rubber factory daily. Ademoroti [1] and Ogiehor *et al* [6] found that industrial effluents creates environmental and public health hazards. Rubber industry pollutes the soil and water since large amount of chemicals like formic acid and ammonia is used in this industry. The high level of phosphate and ammonia in rubber effluent makes it a good medium for algal growth and can result in eutrophication of surface water if discharged without proper treatment Iyagba *et al.*, [4].

MATERIAL AND METHODS

The present investigation is the physico-chemical study of effluents from four rubber industries situated at Nagercoil among which three are gloves producing industries, and one is latex concentrate producing industry. A comparative study was carried out between gloves producing industry and latex concentrate producing industry. The latex concentrate is used in industries manufacturing surgical gloves, condoms, etc. Ammonia is the most widely used preservative for Latex. Since these effluents were used for irrigation, the irrigation quality of these effluents was calculated by using sodium adsorption ratio. The rubber industry effluents were collected from four industries for period of four months and the physico chemical characteristics were analysed as per standard methods APHA, [2]. pH was measured using pH meter. The amount of chlorine was calculated by Mohr's method of titration of chlorine with $AgNO_3$ using potassium dichromate as indicator and sulphate was calculated by using spectrophotometer. Amount of calcium and magnesium was calculated by using versanate titration method and of sodium using flame photometer. Sodium adsorption ratio was calculated using the formula

$$SAR = [Na^+] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}$$

Where sodium, calcium and magnesium are in milli equivalents/L.

RESULTS AND DISCUSSION

The pH of the three gloves producing industry ranges from 6.63 – 8.53. Usually ammonia is used as a preservative for latex. This increases the pH of the latex. The pH value of latex concentrate producing industry ranges from 2.5 – 4.9. (Table 1) The pH recorded showed low level of pH which is usually due to the use of acids in the coagulation of latex. Ogiehor *et al.* [7] observed that the low pH is also responsible for the low and high counts of fungi and bacteria respectively. So the effluent from gloves producing industries are slightly acidic, neutral or slightly alkaline. But the effluent from latex concentrate producing industry is acidic in nature. Generally water having pH 4.5-8 contain bicarbonates and the water having pH above 8 contain carbonates. B.K.Sharma [11]. The same trend is observed in the present investigation. The samples having pH above 8 contain carbonates and the samples containing pH 4.5 – 8 contains bicarbonates (Table 1). The amount of carbonate is nil in month 4. Bicarbonate is nil in samples A and B during month 1. The effluents contain carbonates and bicarbonates and it causes many problems to plants. Bicarbonates cause precipitation of calcium as calcium carbonate resulting in higher sodium hazard because of less calcium level. The presence of carbonate and bi carbonate causes alkalinity problems. The concentration of carbonate causes root injury to plants.

The electrical conductivity ranges from $1dS^{-1}$ to 21.5 dS^{-1} (Table 1). The electrical conductivity of sample D is higher compared with other samples. The amount of anions and cations present in the latex concentrate producing industry is more than the effluents from gloves producing industry.

The amount of chlorides in samples A, B, C ranges from 70.8 mg/L to 725.69 mg/L. The amount of chloride in sample D ranges from 513.3 mg/L to 7540.2 mg/L. (Table 1) chloride amount is very low in month 4, comparing to other months. According to Mass [6] chloride concentrations up to 70 mg/L are essential for the growth of plants. The plants may incur some injury when the chloride concentration is 70 to 140 mg/L, Chloride concentration between 140-350mg/L is injurious to even moderately tolerant plants. Severe problems can be expected at concentrations above 350 mg/L chloride. The sample D contains more chloride and sulphate than other samples and so the sample D is more acidic and the pH of sample D is very low. The polluted water from these rubber industries are used for irrigation purpose. The leaves of the plants are sensitive to chloride. Chloride toxicity in plants includes necrosis of leaf margins and tips, at high concentrations chloride might be toxic to many crops and contributes to the overall salinity. The chloride ion can be taken up by plant roots and accumulate in the leaves.

The amount of sulphate in samples A, B and C ranges from 48 mg/L to 96 mg/L. The amount of sulphate in sample D ranges from 470.40 mg/L to960 mg/L. The high sulphate concentration of latex concentrate effluent is due to the use of the sulphuric acid in the coagulation process of latex concentrate production.

The amount of magnesium ranges from 0 mg/L to 1025.46 (Table 1). Lowest amount of magnesium is present in sample B and C and highest amount of magnesium is present in sample D. The use of magnesium rich water for irrigation results in deterioration of physical and chemical properties of soil, which in turn plays an important role in affecting the yield of the crop. Yadav *et al* [12] and [13].

The amount of calcium ranges from 8 mg/L to 910 mg/L. Highest amount of calcium is present in sample D and the lowest amount of calcium is present in sample C. (Table 1). The amount of sodium in samples ranges from 36.800 mg/L to 4593.6 mg/L (Table 1). Lowest and highest amount of sodium is present in sample D. Problems can occur if sodium and chloride levels in water exceed 50 and 70 ppm, respectively. High concentrations of sodium in irrigation water can induce calcium and potassium deficiency in soils. The amount of potassium in samples ranges from 19.5 mg/L to 4442.1 mg/L. (Table 10). The amount of potassium is higher in sample D during month 1. The sodium and potassium destroy the beneficial micro organism in soil. The DO is nil in all the samples indicating highly obnoxious condition. This may be due to increased activity of microorganisms in the water which consumes a lot of oxygen due to metabolic process and the decomposition of organic material. The presence of a number of viable and indicative bacteria in the skim serum effluent makes it a highly oxygen absorbing liquid. S.K. Gadkari et.al , [3].

Sodium Absorption Ratio (SAR) is a measure of the suitability of water for use in irrigation as determined by the concentrations of solids dissolved in the water. It is also a measure of the sodicity of soil, as determined from analysis of water extracted from the soil.

The formula for calculating sodium adsorption ratio is:

$$SAR = [Na^{+}] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}$$

Where sodium, calcium, and magnesium are in milliequivalents/L.

In general, higher the sodium adsorption ratio, the less suitable the water for irrigation. Irrigation using water with high sodium absorption ratio may require soil amendments to prevent long-term damage to the soil. Calcium and magnesium are a problem for water that is used for irrigation. They can build up in the soil, and the excess salinity can reduce crop growth or make the soil completely infertile. Irrigation waters are classified by Richards [9] based on sodium absorption ratio. If the ratio is between 0 to 10 the water is excellent and it is good , if it varies from 10 to 18. The quality of water is fair if the ratio ranges from 18 to 28 while it is poor beyond 28. In the present investigation the sodium absorption ratio is less than 10 in most of the samples and so the water is excellent for irrigation. The sodium absorption ratio of sample D is 25.58 during month 2 and so the quality of water is fair for irrigation (Table 1). The sodium absorption is higher in month 2 in all the samples.

Table 1 Physical and Chemical parameters

Parameter	Name of industry	Month 1	Month 2	Month 3	Month 4
pH	A	8.6	8	8.5	6.6
	B	8.2	7.6	7.7	7.3
	C	7.5	7.7	7.6	7.4
	D	4.9	2.5	2.9	4.6
Electrical Conductivity	A	2.5	2.0	1.1	1.8
	B	0.9	1.8	1.6	1.9
	C	1.7	2.9	1	2.3
	D	11.2	21.5	18.2	17.7
Carbonate	A	24	24	18	-
	B	12	-	-	-
	C	-	-	-	-
	D	-	24	-	-
Bicarbonate	A	-	122	219	585
	B	-	122	292	756
	C	268	244	109	488
	D	488	-	-	1317
Chloride	A	725.69	637.19	283.2	70.8
	B	265.5	566.4	495.59	123.89
	C	354	708	212.39	212.39
	D	3540	3610.79	7540.2	513.3
Sulphate	A	96	-	-	96
	B	48	-	-	48
	C	48	96	96	-
	D	470.40	960	720	696
Calcium	A	80	48	24	104
	B	44	128	36	148
	C	40	196	8	208
	D	910	144	28	28
Magnesium	A	97.2	43.74	43.74	68.039
	B	34.019	92.34	111.78	-
	C	68.039	7.29	41.31	-
	D	97.2	252.720	1025.46	234.495
Sodium	A	243.79	439.3	80.5	161
	B	126.5	400.2	46	144.9
	C	92	464.599	115	220.79
	D	213.9	4593.6	172.5	36.800
Potassium	A	156	58.5	113.1	245.7
	B	553.8	58.5	113.1	273
	C	569.4	198.89	19.5	195
	D	4442.1	1150.5	1064.7	865.8
SAR	A	4.34	11.04	2.15	3.04
	B	3.46	6.69	0.87	3.32
	C	2.05	8.77	3.67	2.85
	D	1.79	25.58	1.14	0.50

In the present study all the parameters show a slight variation in three gloves producing industry and the values are entirely different in latex concentrate producing industry. The effluent from latex concentrate producing industry is acidic in nature and the effluents from gloves producing industries are slightly acidic or slightly alkaline in nature. This proves that the latex concentrate producing industry contains more pollutants than gloves producing industry. The dissolved oxygen is nil and so it produces foul smell. If the untreated effluents from rubber latex centrifuging units are discharged into any stream or river, it will deplete the dissolved oxygen concentration of the water body due to the high organic content, thus affecting the survival of aquatic life. The acidic nature of the effluent also may affect the growth of fish and other aquatic life. The foul smell and dirty appearance of the polluted water is unhealthy even for bathing. The menace of water-borne diseases and epidemics still looms large on the populace of developing countries like India. The presence of excess of chloride and magnesium in this effluents makes this effluent unfit for irrigation.

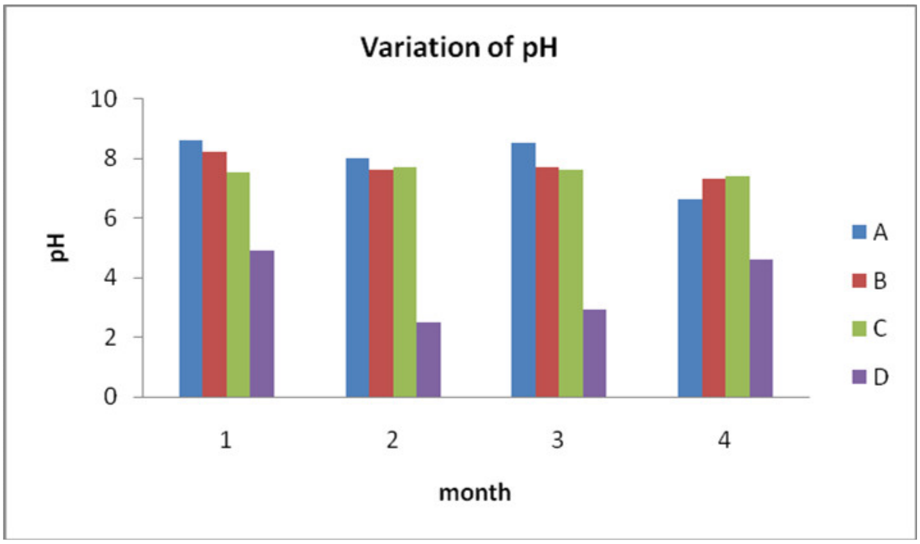

Figure 1 Variation of pH

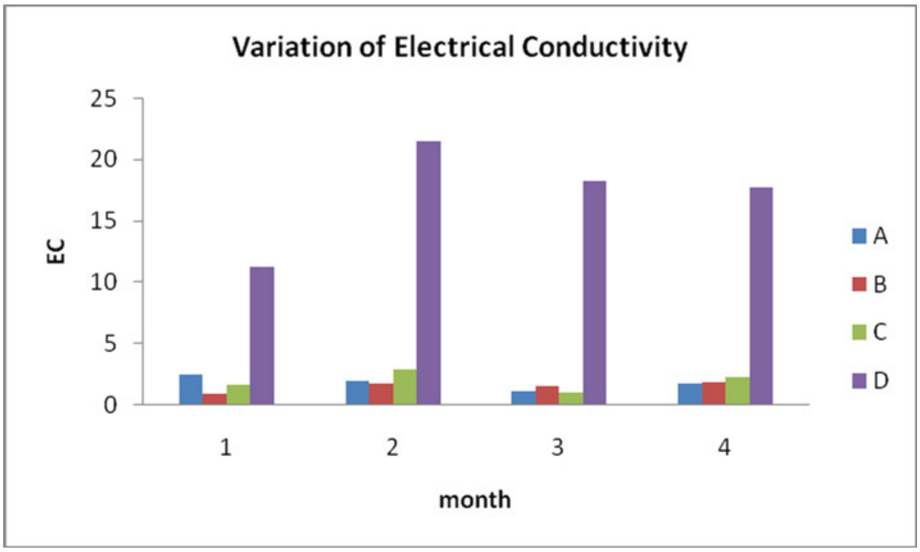

Figure 2 Variation of Electrical Conductivity

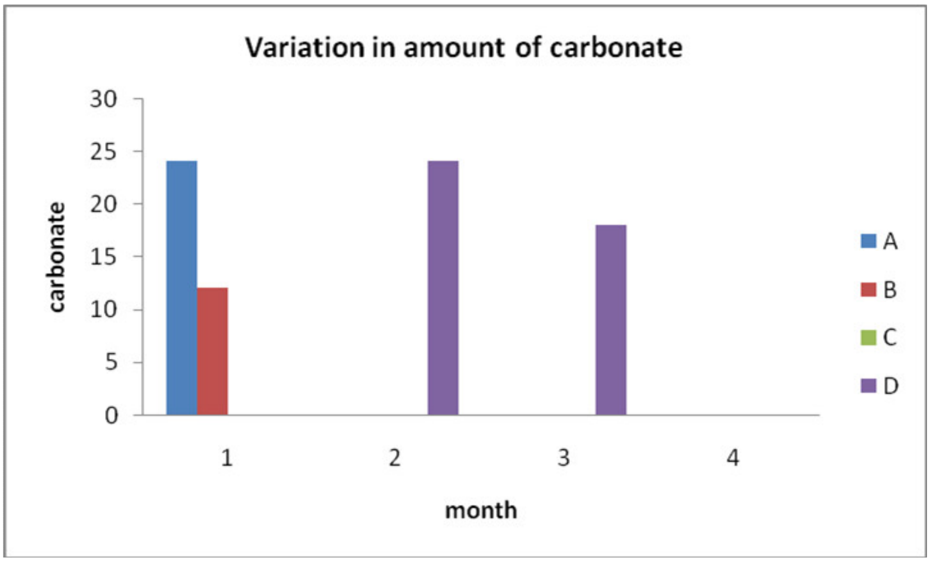

Figure 3 Variation in amount of carbonate

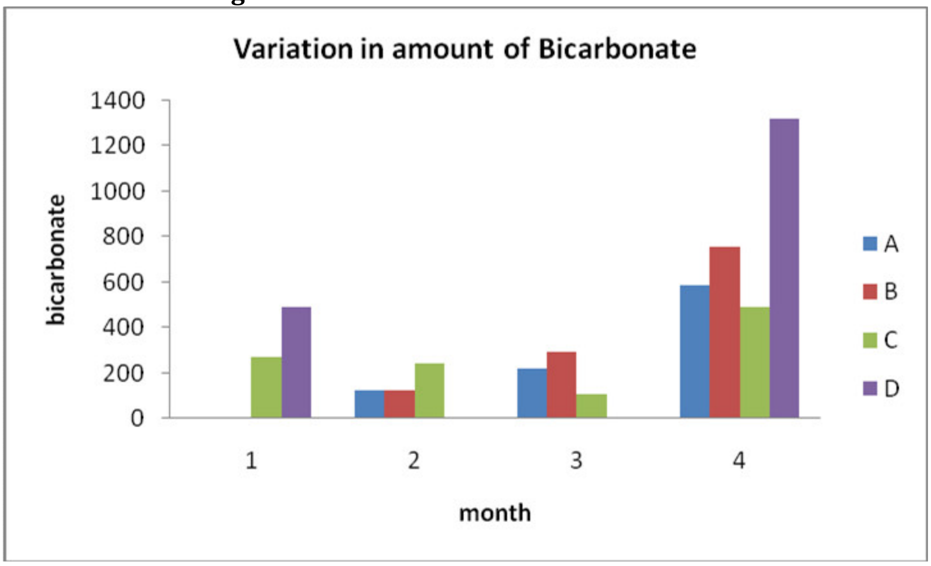

Figure 4 Variation in amount of Bicarbonate

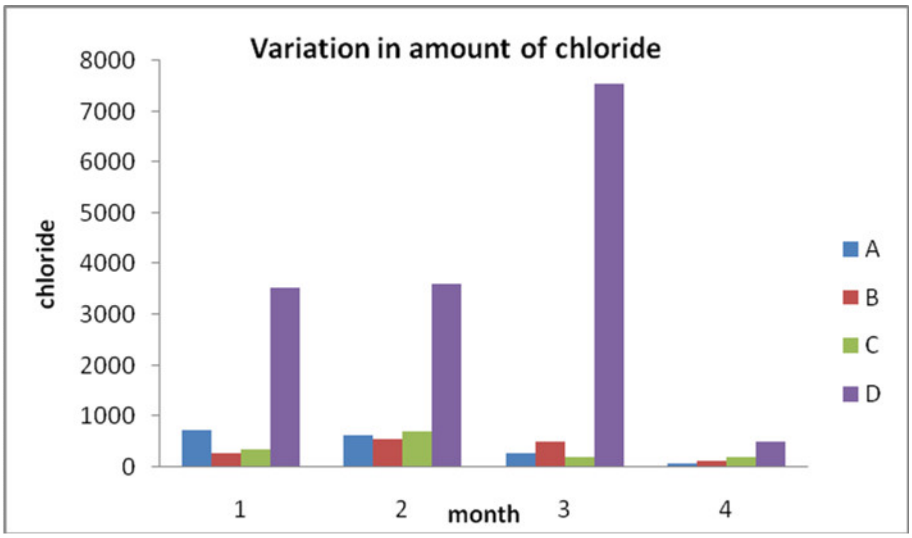

Figure 5 Variation in amount of chloride

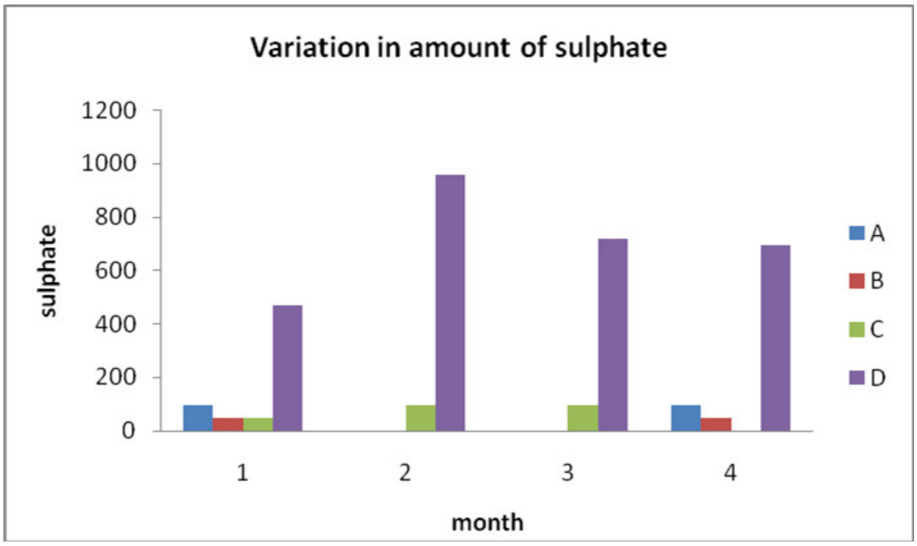

Figure 6 Variation in amount of sulphate

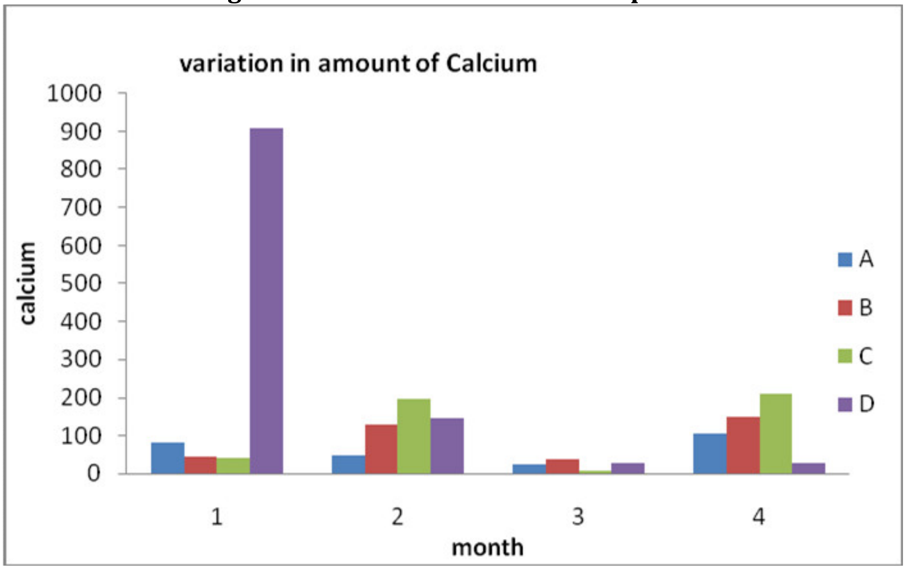

Figure 7 Variation in amount of calcium

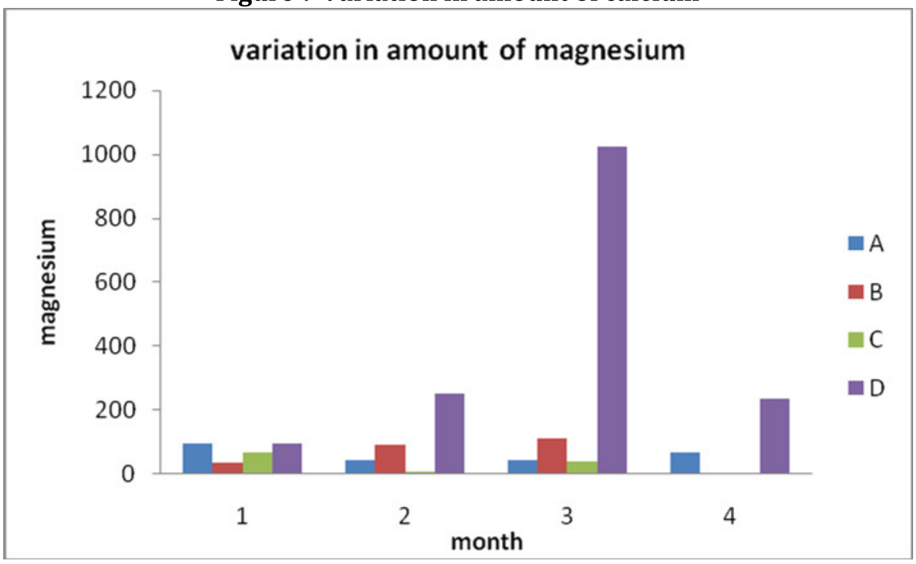

Figure 8 Variation in amount of Magnesium

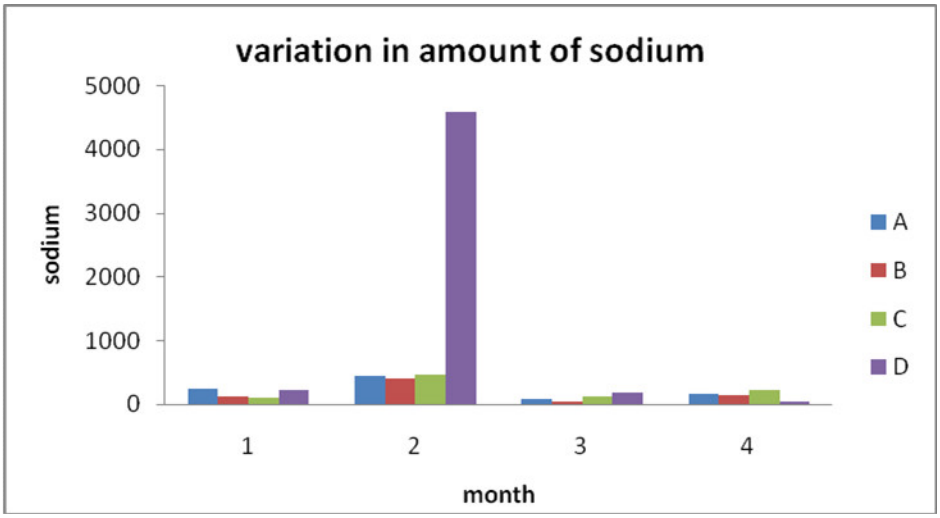

Figure 9 Variation in amount of sodium

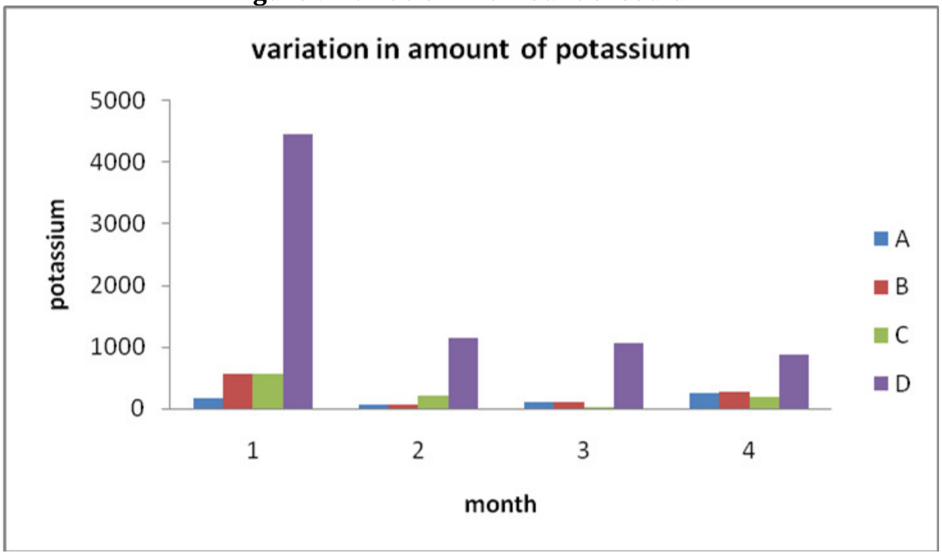

Figure 10 Variation in amount of potassium

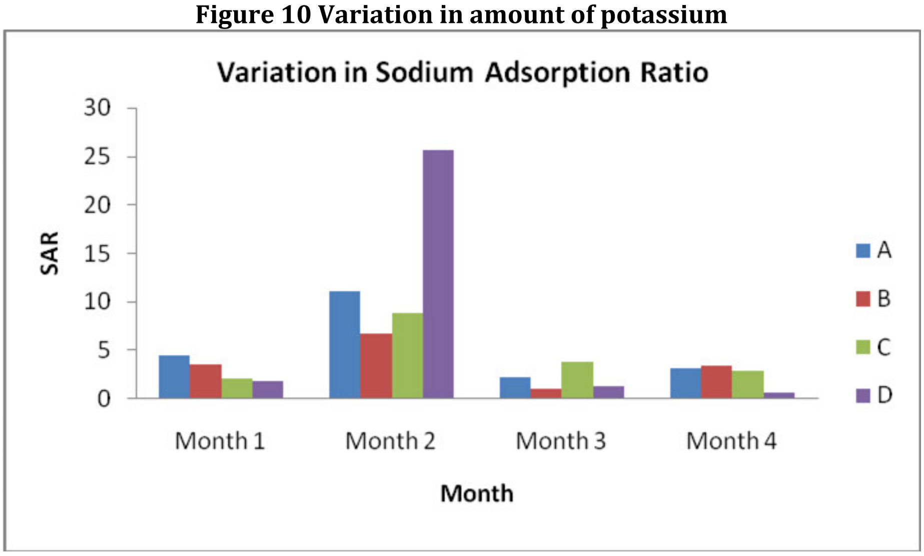

Figure 11 Variation in sodium adsorption ratio

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