اتحاد المهندسين الزراعيين العرب
الأمانة العامة
دمشق - ص.ب : ٣٨٠٠
فاكس : ٣٣٣٩٢٢٧
هاتف : ٣٣٣٥٨٥٢

المؤتمر الفني الدوري الحادي عشر
التكامل العربي
في مجال استخدام التقنيات
الحديثة في الزراعة العربية

التتبع الكيمائي لمخلفات الصرف الصحي لاستعمالها في انتاج المحاصيل

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النقابة العامة للمهندسين الزراعيين
الجماهيرية العظمى

الرباط ١١ - ١٥ / ١٢ / ١٩٩٥

التتبع الكيميائي لمخلفات الصرف الصحي لإستعمالها في انتاج المحاصيل

II نوعية مياه الري للمخلفات السائلة المعالجة .

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مستخلـــــــص

تستعمل المياه المعالجة بمحطة طرابلس لمعالجة مياه الصرف الصحي في ري العديد من المحاصيل بمشروع الهضبة الخضراء الزراعي الإنتاجي . في هذه الدراسة أخذت عينات من المياه المعالجة والمستعملة في الري بصفة دورية (شهريا) ولمدة تتفاوت من 14 الى 24 شهرا لغرض تتبع كل من الأملاح الذائبة الكلية ، درجة التفاعل والتوصيل الكهربائي . كما تم قياس أو تقدير تركيز كل من النيتروجين الكلي ، الفسفور المتيسر ، البوتاسيوم ، الكالسيوم ، المغنيسيوم ، الصوديوم ، الحديد ، المنجنيز ، النحاس ، الزنك ، الكادميوم ، الكروميوم ، النيكل ، الكوبلت والرصاص .

لقد أظهرت نتائج التحاليل لعينات المياه المعالجة أن هناك امكانية لتراكم كميات كبيرة من الأملاح بالتربة مع الإستعمال المستمر لهذه المياه في الري . كما أفادت نتائج التحاليل أن اغلب العينات تحتوي على تركيزات عالية من الكلوريدات والبيكربونات ونسبة الصوديوم المدمص المعدلة . أما بالنسبة للعناصر الثقيلة (الحديد ، المنجنيز ، النحاس ، الزنك والرصاص) فكان تركيزها أقل من التركيزات الحرجة لهذه العناصر (5.0 ، 0.2 ، 0.2 ، 2.0 ، 5.0 جزء في المليون) على الترتيب ، في جميع العينات تقريبا . أما تركيزات الكادميوم ، الكروميوم ، النيكل والكوبلت فقد كانت أكبر من التركيزات الحرجة لهذه العناصر (0.01 ، 0.10 ، 0.20 و 0.05 جزء في المليون) في المياه المعالجة في (67 ، 13 ، 8 و 21%) من العينات التي تم اختبارها على الترتيب .

هذا وقد تم مناقشة العديد من خصائص هذه المياه وخاصة ذات العلاقة بخواص التربة وامكانية تأثيرها على نمو النبات .

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CHEMICAL MONITORING OF SEWAGE WASTES FOR THEIR USE IN CROP PRODUCTION

II. IRRIGATION WATER QUALITY OF TREATED EFFLUENT WASTE.

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ABSTRACT

Treated effluent waste from the Tripoli Sewage Treatment Plant is being used invariably to irrigate various crops produced in Al-Hadba Al-Khadra Agricultural Production Project. Samples , from the reclaimed water used for irrigation, were collected monthly for a period of time varies from 14 to 24 months , for monitoring TDS, pH, and soluble salts . Concentraitions of total N, P, K, Ca, Mg, Na, Fe, Mn, Cu, Zn, Cd, Cr, Ni, Co,and Pb were also measured .

Various analyses of the collected treated water samples indicated potential loading of soils with high amounts of soluble salts by continous use of this water. Most effluent samples had excessive levels of Cl, HCO3, and high adjusted SAR. Concentrations of Fe, Mn, Cu, Zn, and Pb were less than their critical concentrations of 5.0, 0.2, 0.2, 2.0, and 5.0 ppm in essentially all effluent samples,respectively. Cadmium, Cr, Ni, and Co concentrations were found to be more than their critical levels of 0.01 , 0.10, 0.20, and 0.05 ppm in the treated water in 67, 13, 8, and 21% of the samples tested , respectively .

Various properties of reclaimed irrigation water studied have been discussed in relation to soil characteristics and their possible effects on plant growth . More careful management practices have been warranted after conducting properly designed soil - plant studies.

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Treated municipal effluent waste would be an important source of irrigation water in future for crop production in Libya . About 15 sewage treatment plants located in various parts of the country would be supplying about five percent of the total water required for agriculture purposes (11,23) . This source of irrigation water is of further importance for crop production during scanty raifall summer months in the coastal belt of the mediterranean (12) .

The two fold importance of irrigating crops with treated municipal effluent waste is to provide low-cost water source and plant nutrients contained in waste water (4, 10, 14, 15, 17, 20, 21) . Furthermore, this also resolves the problems of sanitation and provides " living filter of soil " before this water recharges the ground water reservoir . Nevertheless, some of the nuisances associated with using the treated wastewater for irrigation are: the effects on the irrigation system itself, loading soils with soluble salts, and offering plant absorbing surfaces with toxic levels of certain elements hazardous both for animal and human health (4, 5, 9, 10, 21, 22) .It should be noted that, in the first part of this study , we found that the sludge samples contain higher levels of Zn, Pb, Ni, and Cd than their critical levels (2) . Therefore, a constant and carefull watchfullness is warranted of what is being used for .

Tripoli Municipal Sewage Treatment Plant is currently supplying treated wastewater to Al-Hadba Al-Khadra Agricultural Production Project . It is used invariably to meet water requirements of various agronomic as well as horticultural crops without any comprehensive information on its quality for irrigation . This survey was, therefore, carried out to monitor the irrigation quality of the treated waste water .

MATERIALS AND METHODS

Samples from treated effluent used for irrigation collected in plastic bottles after every four weeks interval (monthyl) for a priod of time varies from 14 to 24 months from the Tripoli Sewage Treatment Plant located near Al-Hadba Al-khadra Agricultural Production Project .

Electrical conductivity (EC) and hydrogen ion activity (pH) in the effluent samples were measured by Beckman Solu-bridge and glass-calomel combination electrode assembly connected to a galvanometer, repectively. Concentrations of HCO3- , Cl- and SO4= were determined in the water samples according to the methods described in USDA Handbook no. 60 (24) .

For determining total percent solids duplicates, 200 ml each, of water samples were taken into dried, preweighed evaporating dishes . They were dried to a constant weight at 100 C, whereby loss in weight was determined to calculate the amount of total solids present .

To determine heavy metals, preconcentrated water samples were taken into 100-ml Kjeldahl digestion flasks in duplicates and 10 ml of concentrated HNO3 was added to all samples . The samples were allowed to digest overnight at room temperature . The samples were then placed on the digestion rack and heated slowly until the light brown fumes appeared . Ten ml of diacid mixture (HNO3 : HC104 at 4 : 1) were then added after cooling . The samples were heated until all the HNO3 was boiled off and HC104 fumes appeared . The samples were further digested for 30 more minutes and cooled . The neck of each flask was washed with redistilled water and reheated until perchloric acid fumes were evolved. The samples were diluted and filtered into 100-ml and redistilled water was added to make the volume .Standards were prepared using the same concentrations of acids as for the samples .

The Pye Unicam 2000 atomic absorption spectrophotometer was used to determine the concentration of Fe, Cu, Mn, Zn, Ni, Cd, Cr, Co, Pb, and Mg. Sodium, K and Ca concentrations were determined by flame photometer . For concentration Ca and Mg analysis, Li solution was used to dilute samples and standars to eliminate phosphate interference in their determination (27) .

Total N was determined by the Kjeldahl method (16).Tatal P in the digested samples was determined by ascorbic acid blue color method (28).Total heavy metals and values of alkaline earth cations are reported on volume basis for the water samples (24, 26) .

Glass-wares used in all analyses were cleaned with a lab detergent, diluted HCl and redistilled water. All reagents used were also prepared with redistilled water .

RESULTS AND DISCUSSION

The various data obtained from this study and required to evaluate the salinity and pollution/toxicity problems caused by the irrigation water are presented in Tables 1 and 2 .

Total dissloved solides (TDS) ranged from 0.07 to 0.23% with an average of 0.14% . According to the criteria for TDS ,reported by Hart and Vuuren (14), 21% of the samples tested (TDS < 0.10%) may have detrimental effect on sensitive crops. Other 66% and 13% may adversely affect many crops and should be used for more tolerant crops with careful mangement, respectively . Higher TDS in irrigation waters can clog the soil pores and consequently cause permeability problems (14).

Electrical conductivity (EC) had been measured to predict the effect of the treated water on soil salinity and permeability. The EC range of 1.38 to 2.82 ds/m had always been greater than 0.50 ds/m indicating no permeability problems to water through soils (Figure 1). However, the EC had always been within the range of 0.75 to 3.00 ds/m consedered as the range of " increasing problem " of soil salinity according to the FAO guidelines (3) .

The pH values were also found within the normal range of 6.5 to 8.4 during the whole preiod of investigation (3) .

The chloride concentrations obtained were always more than 10 meq/l in the reclaimed water (figure 2) ,revealing its adverse effects on most sensitive crops (3). Critical limit of 10 meq Cl/l is important when water is applied by surface irrigation . However, as low a concentration as 3 meq/l of either Na^+ or Cl^- , well below their levels observed in the treated effluent, applied by sprinkler irrigation had been reported to be toxic to citrus in several irrigated valleys of California (3) .

It is important to note that in a recent study (29), total dissolved salts in the effluent water had reached 5926.2 micromhos/cm which is much more than what has been obtaind in this study . The increase of salts in the effluent probably reflects the increase of salts in the original water sources through sea water introsion .

Concentrations of bicarbonate obtained in this study (Table 1) were found within the " increasing problem " range of 1.50 to 8.50 meq/l, suggested for overhead sprinkling (3). Higher levels of CO3= and HCO3- in plant growth medium have been found reponsible for plant nutritional problems like Fe chlorosis (7 , 8).

The potential salinity (PS) and adjusted sodium adsorption ratio (SAR adj.) calculated from the efflument chemical analysis data are presented in Table 1. These parameters are usually used to evaluate water quality for irrigation (3 , 13). The calculated potential salinity (Cl + 1/2 SO4) ranged from 14.45 to 25.05, suggesting that this water to be used on soils with good permeability (13). The SAR adj. was calculated to approximate the Na hazard of irrigation water. The SAR adj. varied from 10.49 to 22.24.Unlike EC data,the SAR adj. revealed some possibilities of the permeability problems. According to FAO guidelines (3) , the water samples tested had always SAR adj. of >9 ,suggesting a severe permeability problems on soils dominated by montmorillonite type of clays. For soils with Kaolinite - Sesquioxide as their predominant clay mineral, 29% of the samples were supposed to cause no permeability problem and other 71% were found in the range of " increasing problem " with their SAR adj. between 16 to 24.

Most of the soils in the project are light textured with cation exchange capacity (CEC) values as low as less than 10 meq/100g of soil (unpublished data). They are also mostly *alkaline calcareous in nature . A CEC value of < 10 meq/100 g of soil is an indication of predominance of Koalinite-Sesquioxide clay minerals in the soil. Although, even irrigation with water having EC of < 0.2 mmhos/cm on soils with high initial salt status had been postulated to cause no permeability problems under localised conditions (1), but SAR adj.of > 16 in 71% of the samples tested is suggestive of severe permeability problems in soils dominated by Kaolinite type of clay minerals. Soils with low CEC values would also have less cation binding sites to offer. Therefore, irrigation water having high SAR adj., used on low CEC soil would add higher levels of Na to the soil. This would immediately result in an imbalance among various plant nutrients and high osmotic pressure of the soil solution which would affect water availability to crops (6) .*

Among various trace elements presented in Table 2, Fe, Mn, Cu, Zn and Co are essential plant micronutrients . Cadmium, Cr, Ni , and Pb are nonessential elements for plant growth , but accumulation of any one of them in a soil above a certain level could be toxic both to plant as well as animal life .

Unfortunately most of the criteria available to evaluate the heavy metal toxicity problems of irrigation water are for surface irrigation methods on diffrent soils (22). But the treated effluent used through sprinkler irrigation system in Al-Hadba Al-Khadra Agricultural Project is like foliar application. Nevertheless, the criteria of National Academy of Sciences of USA reported by Page (22) had been used to avaluate the potential heavy metal toxicities from irrigation .

Figures 3 through 6 show that concentrations of Fe, Mn, Cu and Pb were always less than their critical levels of 5, 0.2 0.2 and 5 ppm , respectively in the effluent samples. Zinc concentration too was always less than its critical level of 2 ppm except for one out of the 24 samples tested was 2.74 ppm (Figure 7).

Figures 8 through 11 depect that toxic levels of Cd, Cr, Ni, and Co were found in 67, 13, 8 and 21% of the samples tested, more than their critical concentrations of 0.01, 0.1, 0.2 and 0.05 ppm, respectively .

The management alternatives suggested by others (3) could be adapted to use the reclaimed water safely in crop production. These could also be helpful in alleviating some of the heavy metal toxicity problems from highly varied water source (10, 25) to various crops grown under different soil and climatic conditions (17, 18, 19). However, comprehensive soil-plant studies are suggested both under field and greehouse conditions before any management pratice could be used efficiently .

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Table 1. Summary of some characteristics determining irrigation quality of the treated effluent samples collected from the Tripoli Municipality Sawage Treatment Plant.

Component	No. of Samples	Range	Median	Mean
TDS (%)	24	0.07 - 0.23	0.14	0.14
pH	24	6.80 - 8.20	7.24	7.28
EC.(ds/m)	24	1.38 - 2.82	2.00	2.07
Cl (meq/l)	14	11.50 - 21.50	16.75	16.51
HCO3 (meq/l)	14	2.00 - 5.50	4.18	4.06
SO4 (meq/l)	14	2.70 - 7.10	3.88	4.38
Total N(ppm)	15	10.00 - 40.25	20.00	22.38
P (ppm)	17	10.27 - 15.94	12.70	2.86
K (ppm)	17	16.00 - 60.43	19.06	26.91
Ca (ppm)	17	26.40 -125.93	80.65	77.91
Mg (ppm)	17	40.81 - 87.69	73.77	71.77
Na (ppm)	17	239.97 -503.95	386.96	377.06
SAR adj.	14	10.49 - 22.24	17.32	17.18
PS(Cl+1/2 SO4)	14	14.45 - 25.05	18.03	18.21

Table 2. Summary of some heavy metals concentration in the treated effluent samples collected from the Tripoli Municipality Sawage Treatment Plant .

Metal	No. of Samples	Range	Median	Mean
		(ppm)		
Fe	24	0.06 - 1.18	0.42	0.50
Cu	24	ND * - 0.070	0.010	0.020
Zn	24	0.04 - 2.74	0.15	0.29
Mn	24	0.01 - 0.15	0.04	0.04
Cd	24	ND - 0.060	0.011	0.017
Cr	24	ND - 0.250	0.005	0.030
Ni	24	ND - 0.32	0.06	0.08
Co	24	ND - 0.11	0.03	0.02
Pb	24	ND - 0.32	0.05	0.09

* ND, indicates not detected .

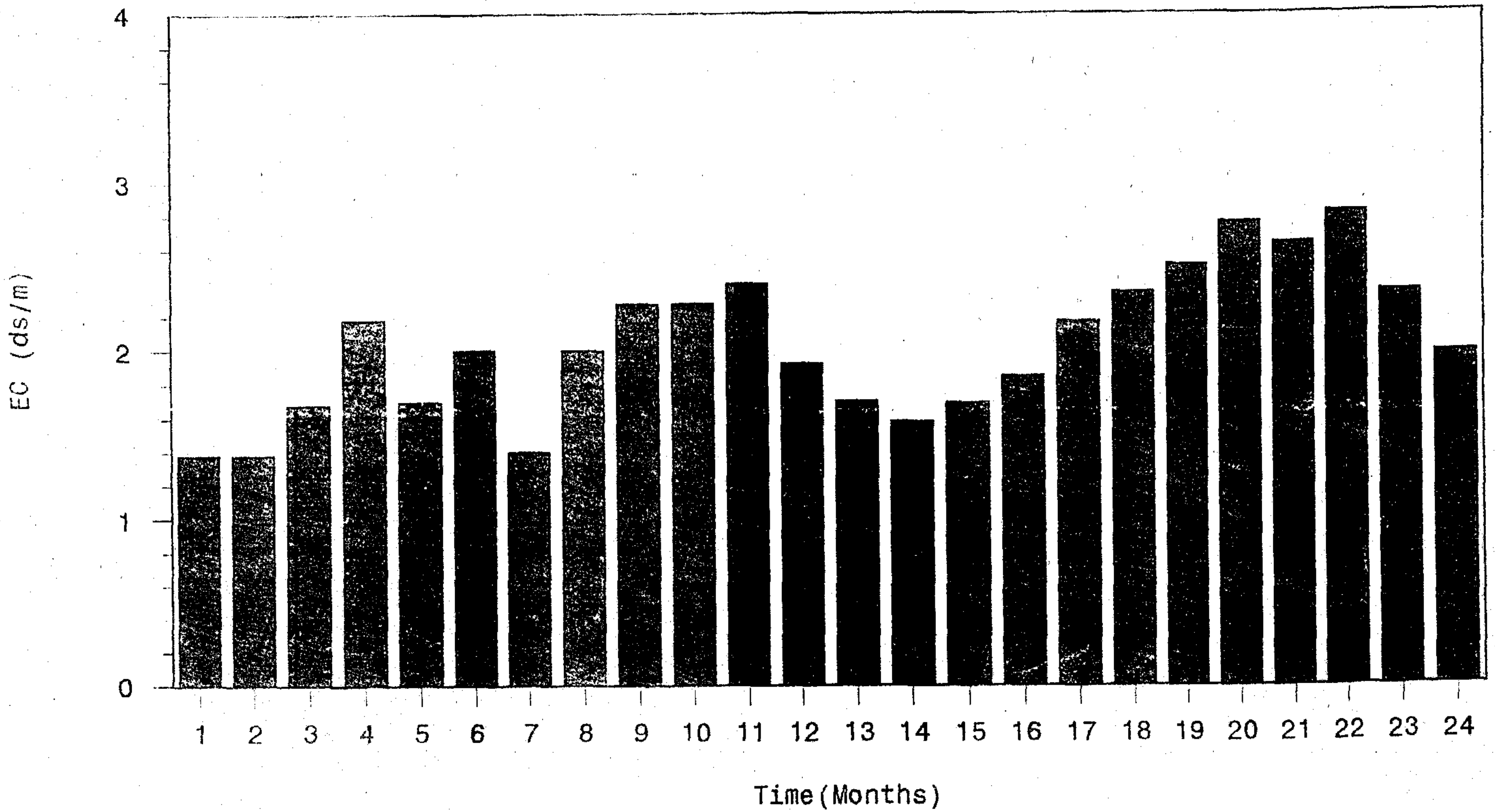

Figure 1 : salinity level in treated effluent as a function of time.

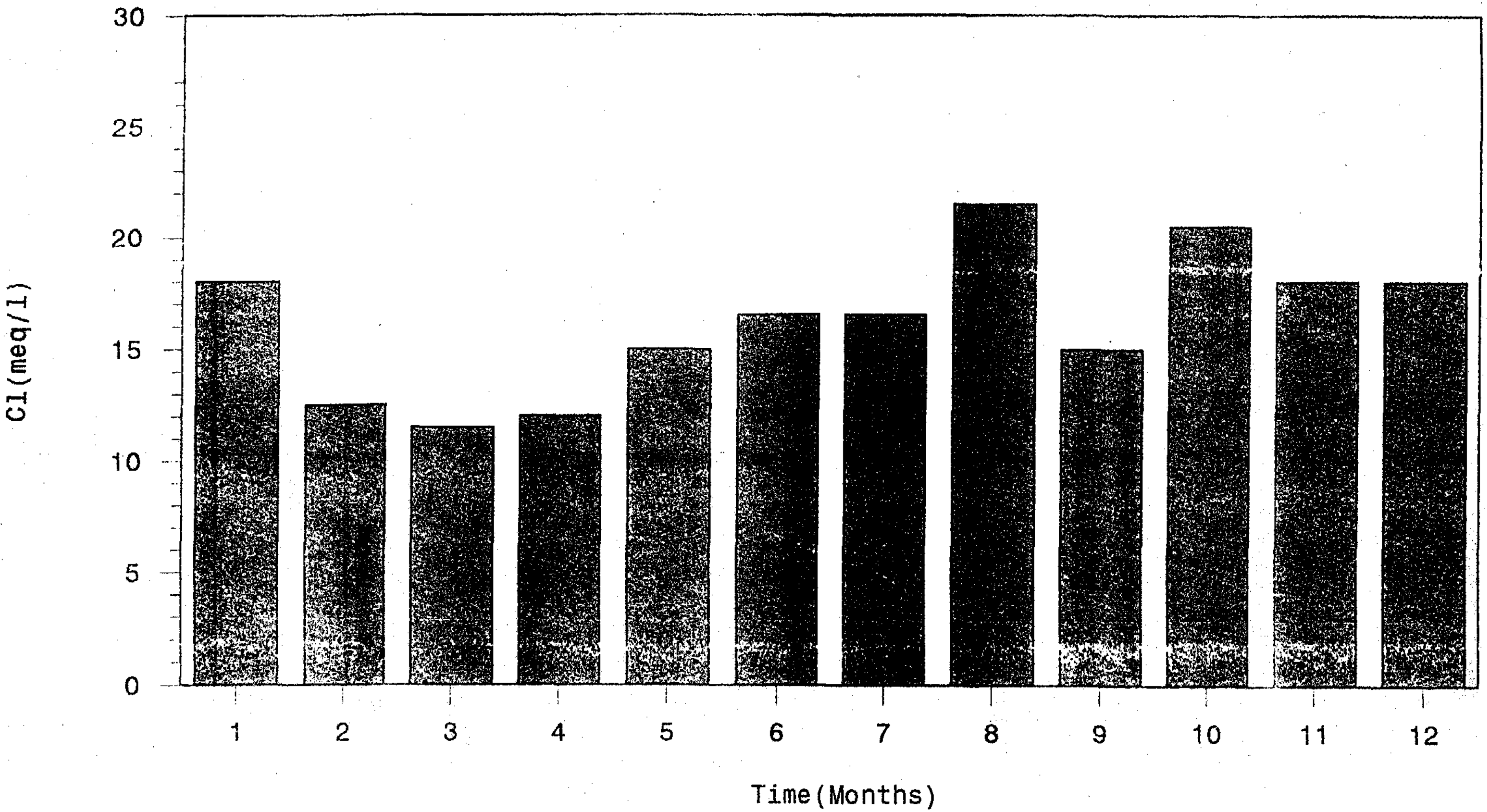

figure 2 :chloride concentration in treated effluent as a function of time .

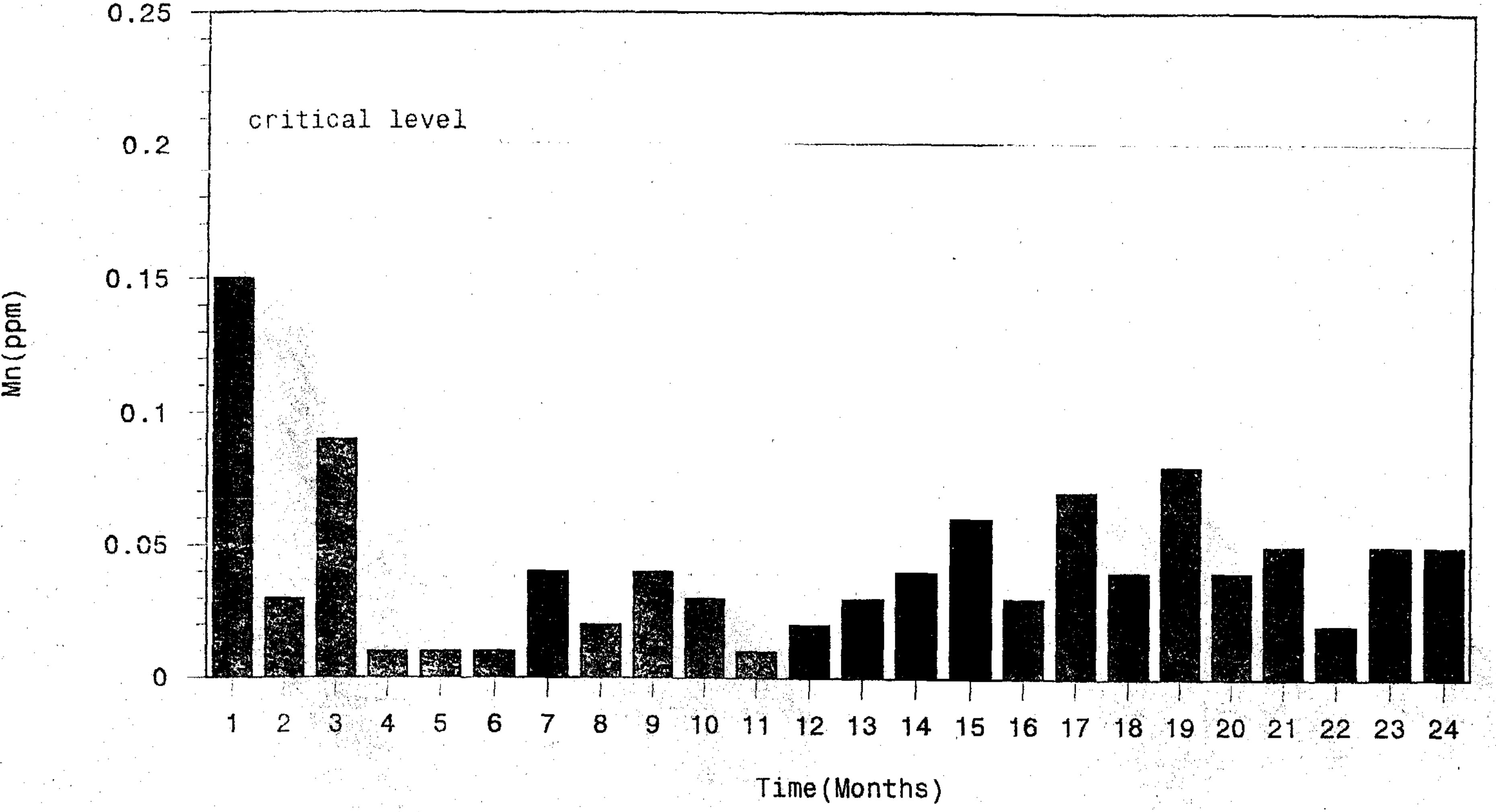

figure 4 : manganese concentration in treated effluent as a function of time .

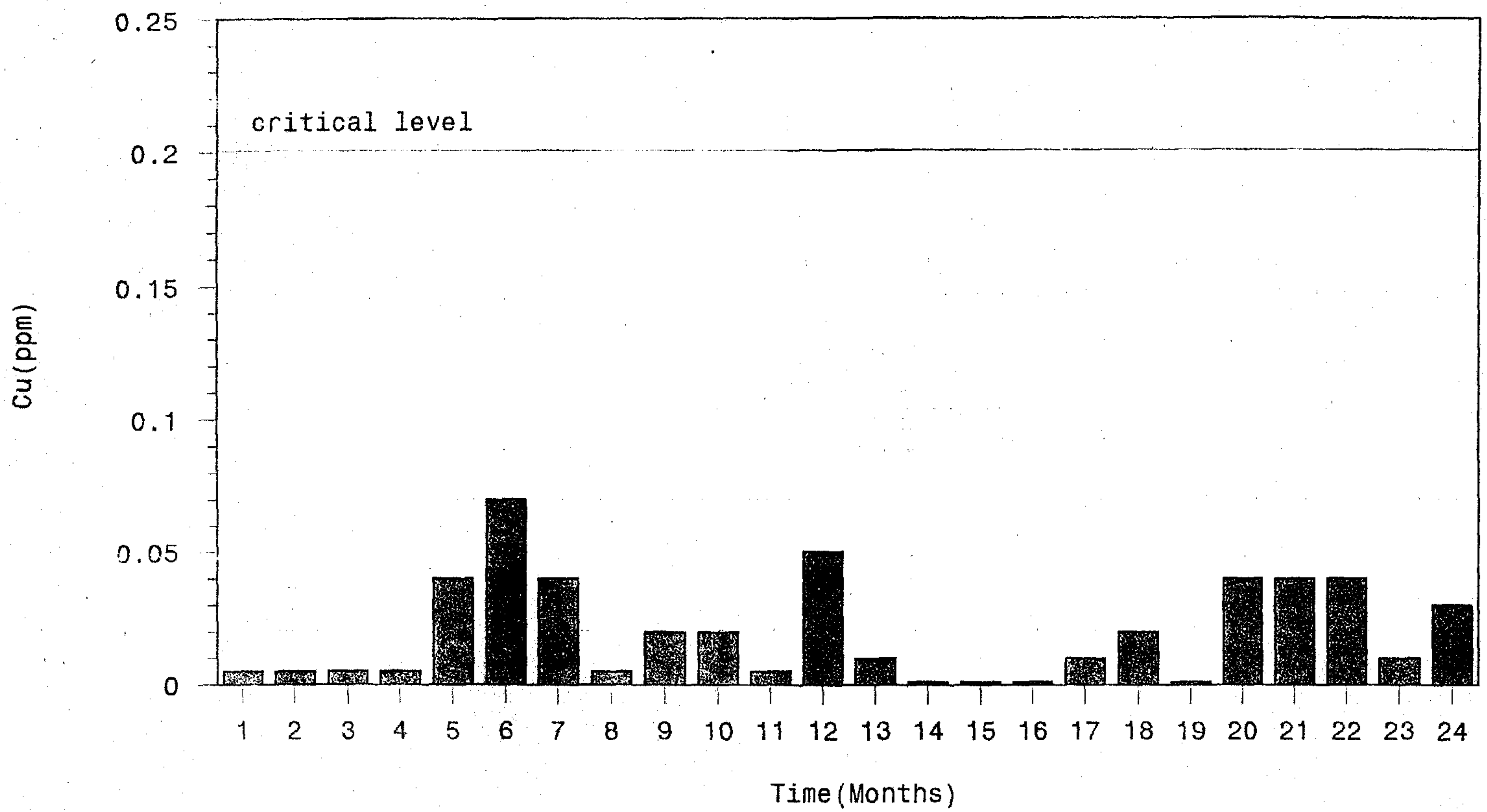

figure 5 : copper concentration in treated effluent as a function of time .

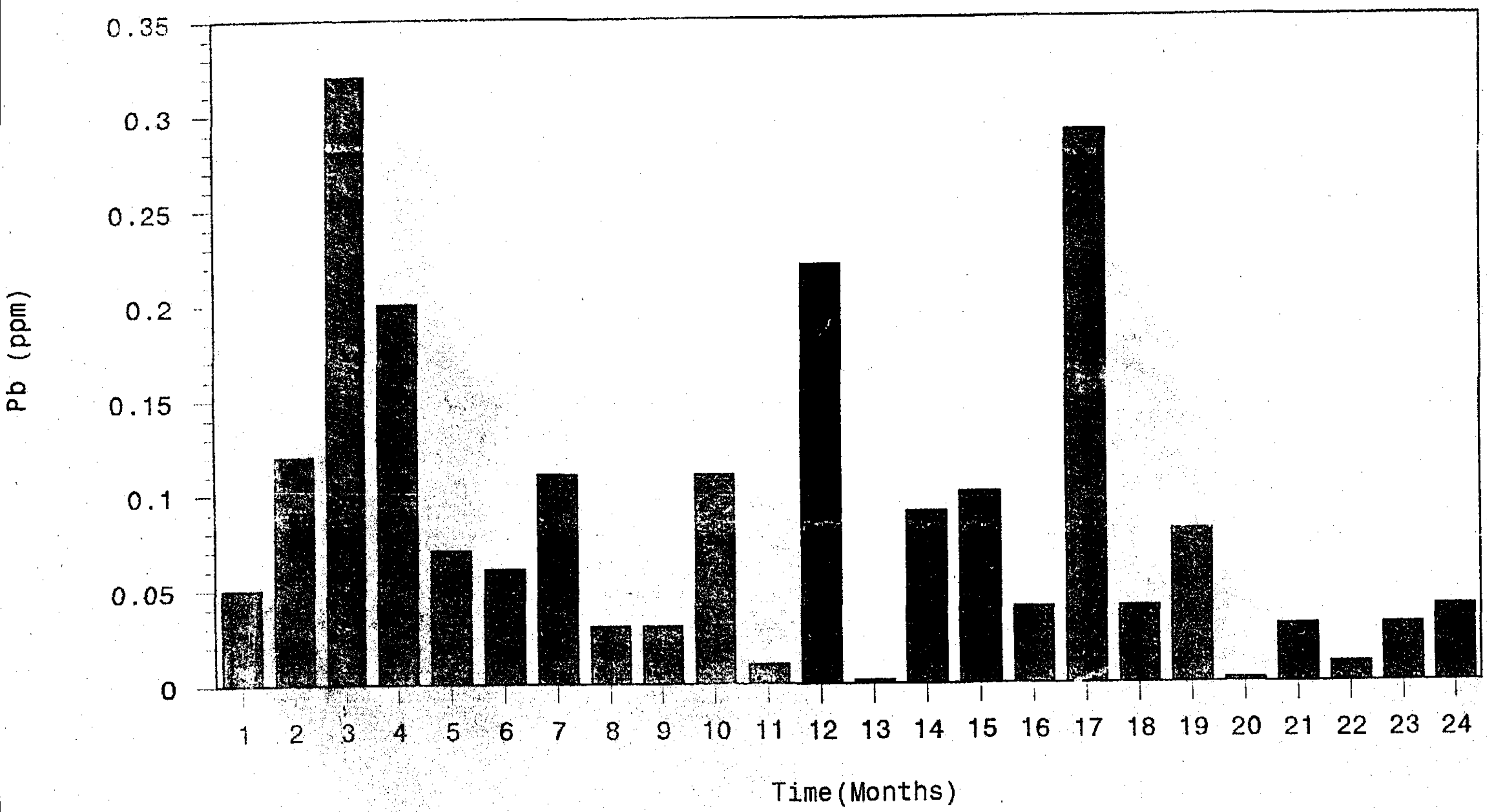

Figure 6 : lead concentration in treated effuent as a function of time .

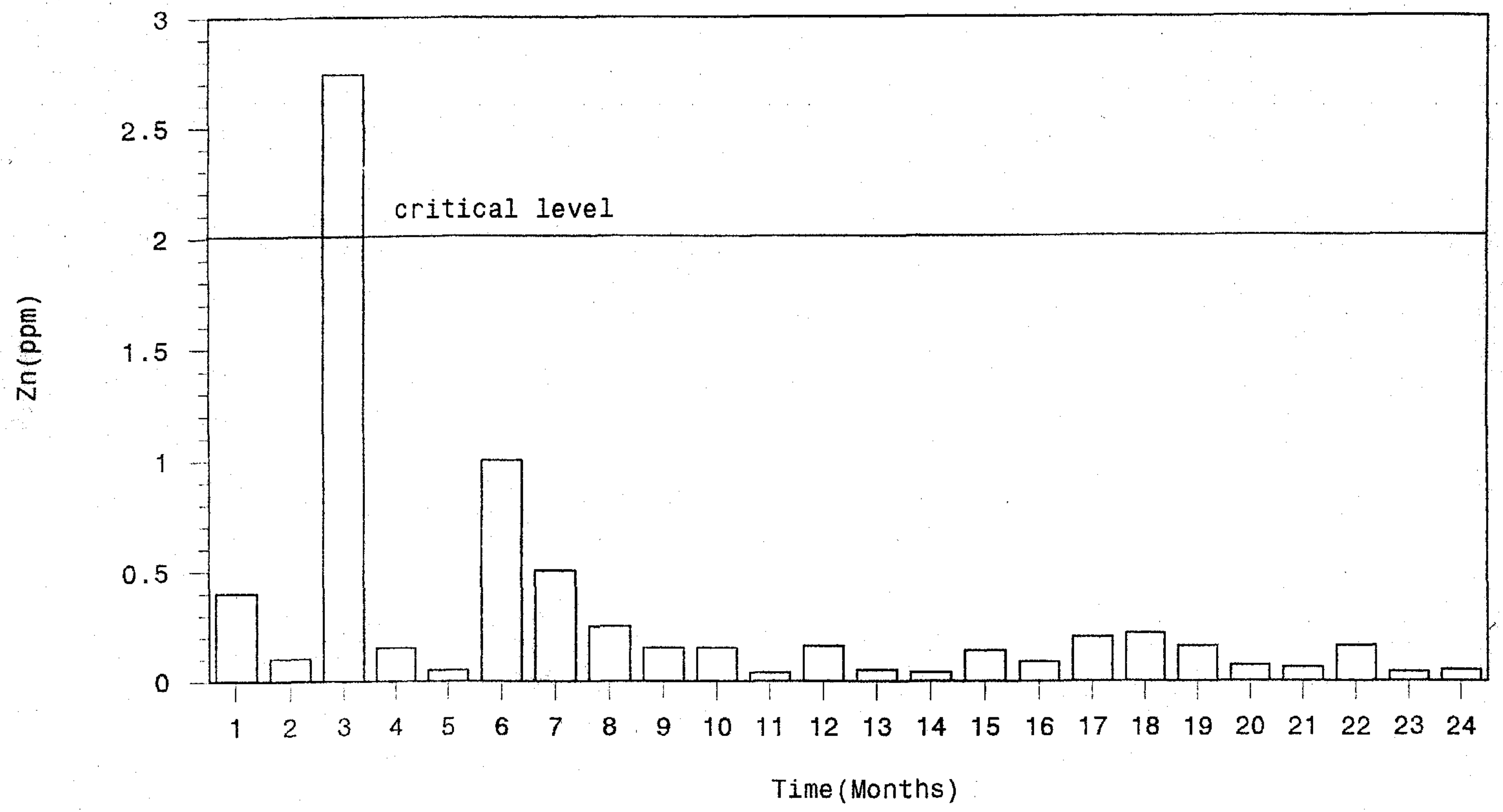

figure 7 : zinc concentration in treated effluent as a function of time .

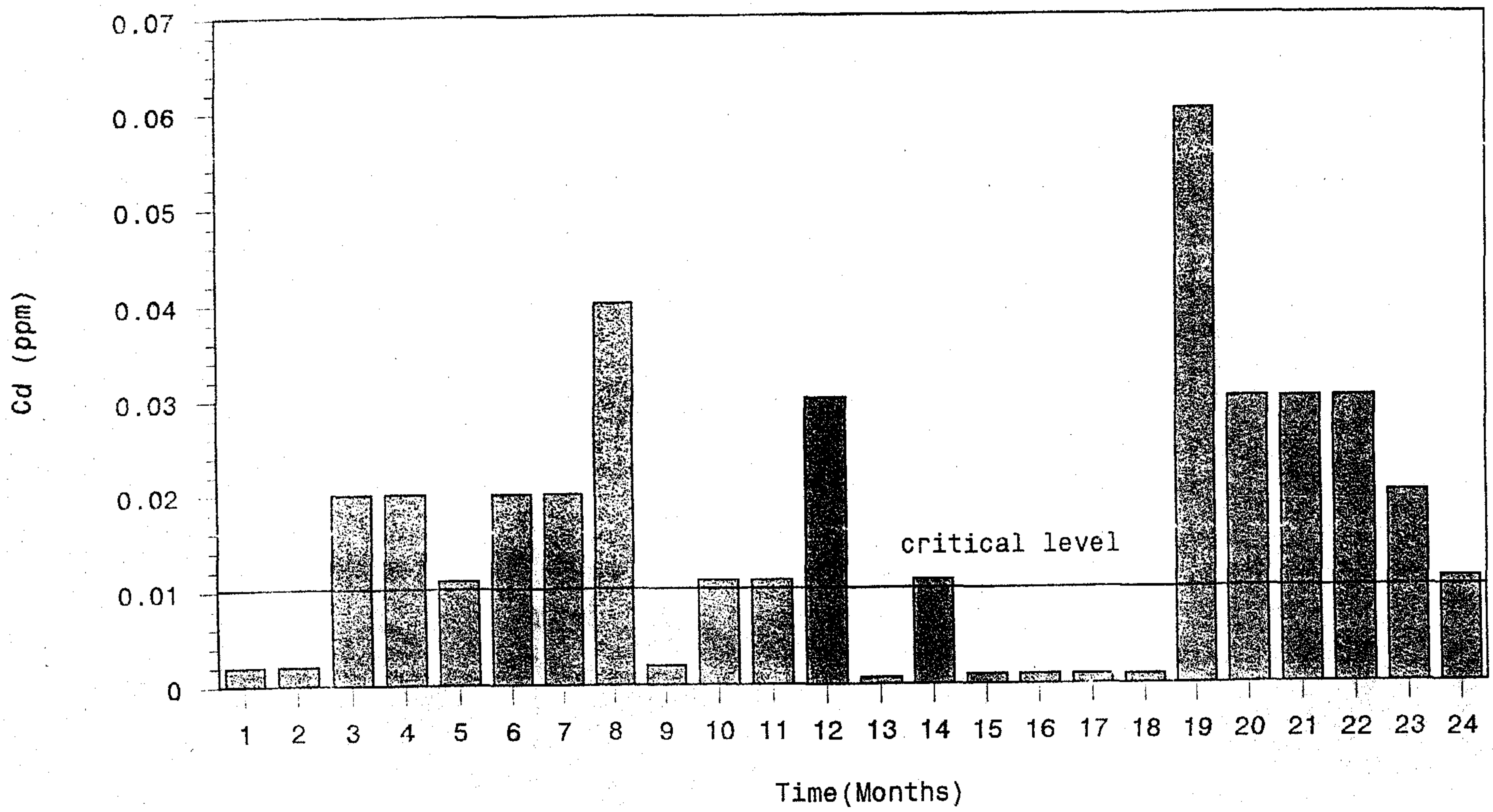

Figure 8 : cadmium con centration in treated effluent as afunction of time .

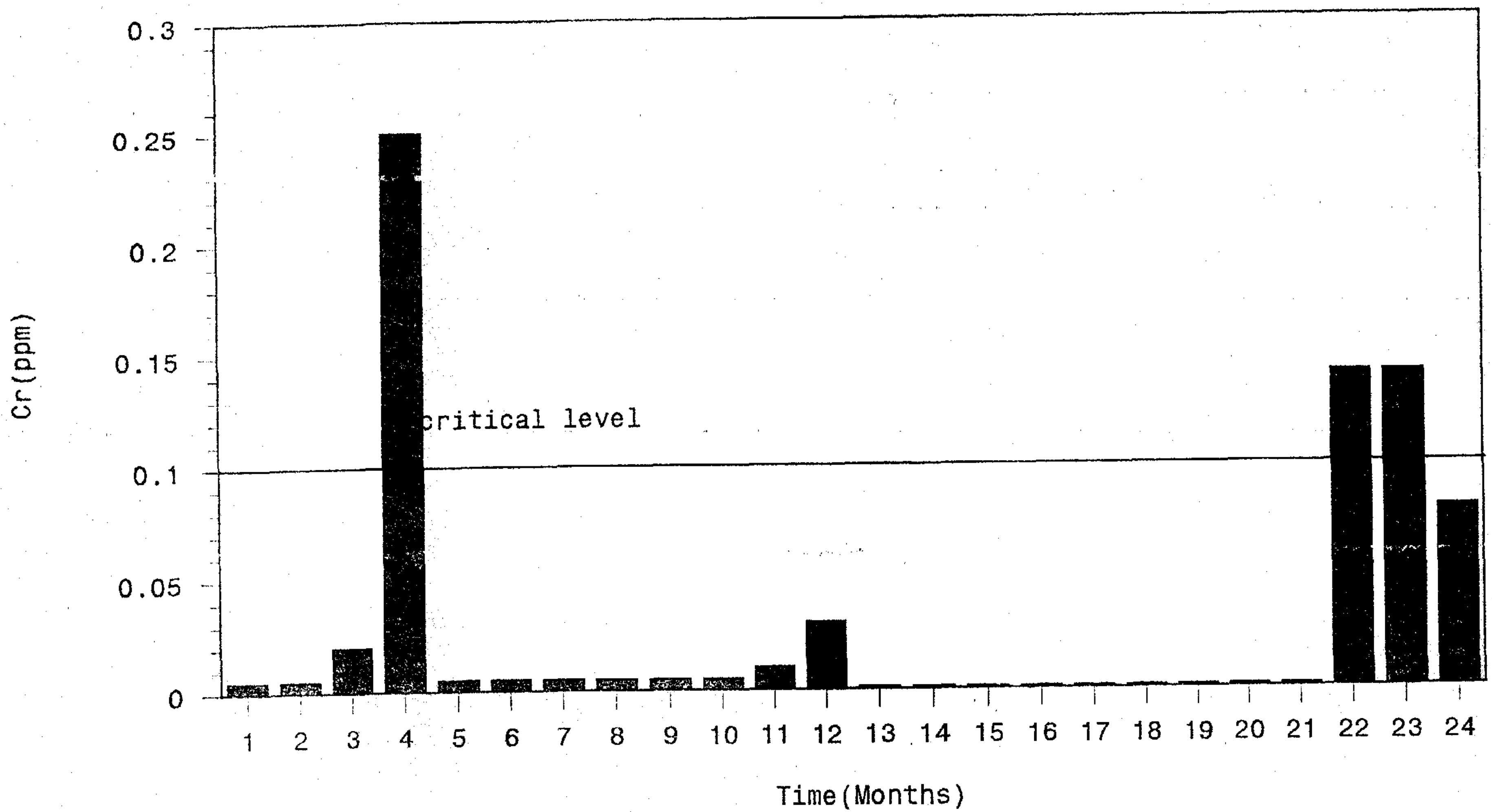

figure 9 :chromium concentration in treated effluent as a function of time .

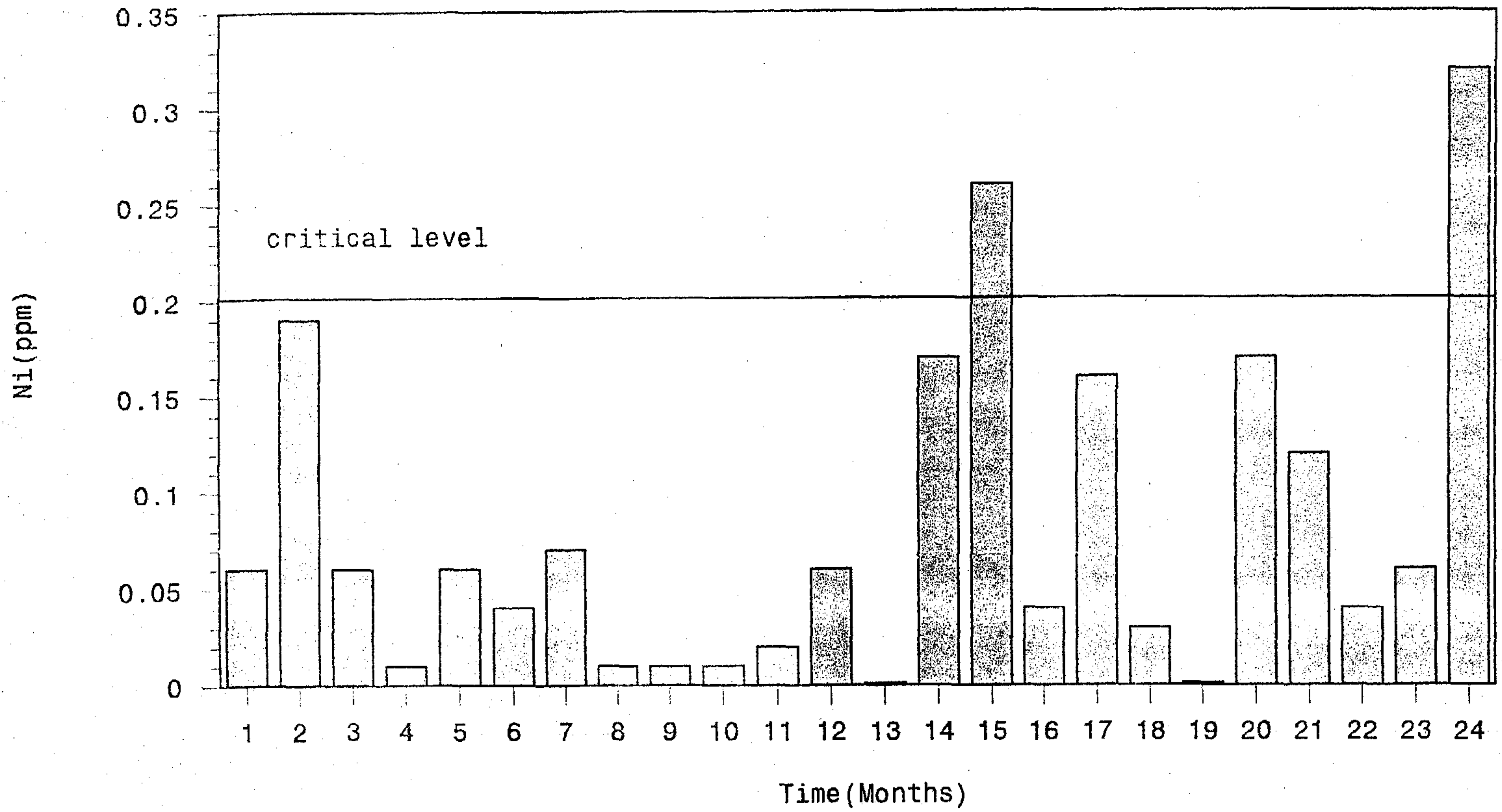

figure 10 :nickel concentration in treated effluent as a function of time .

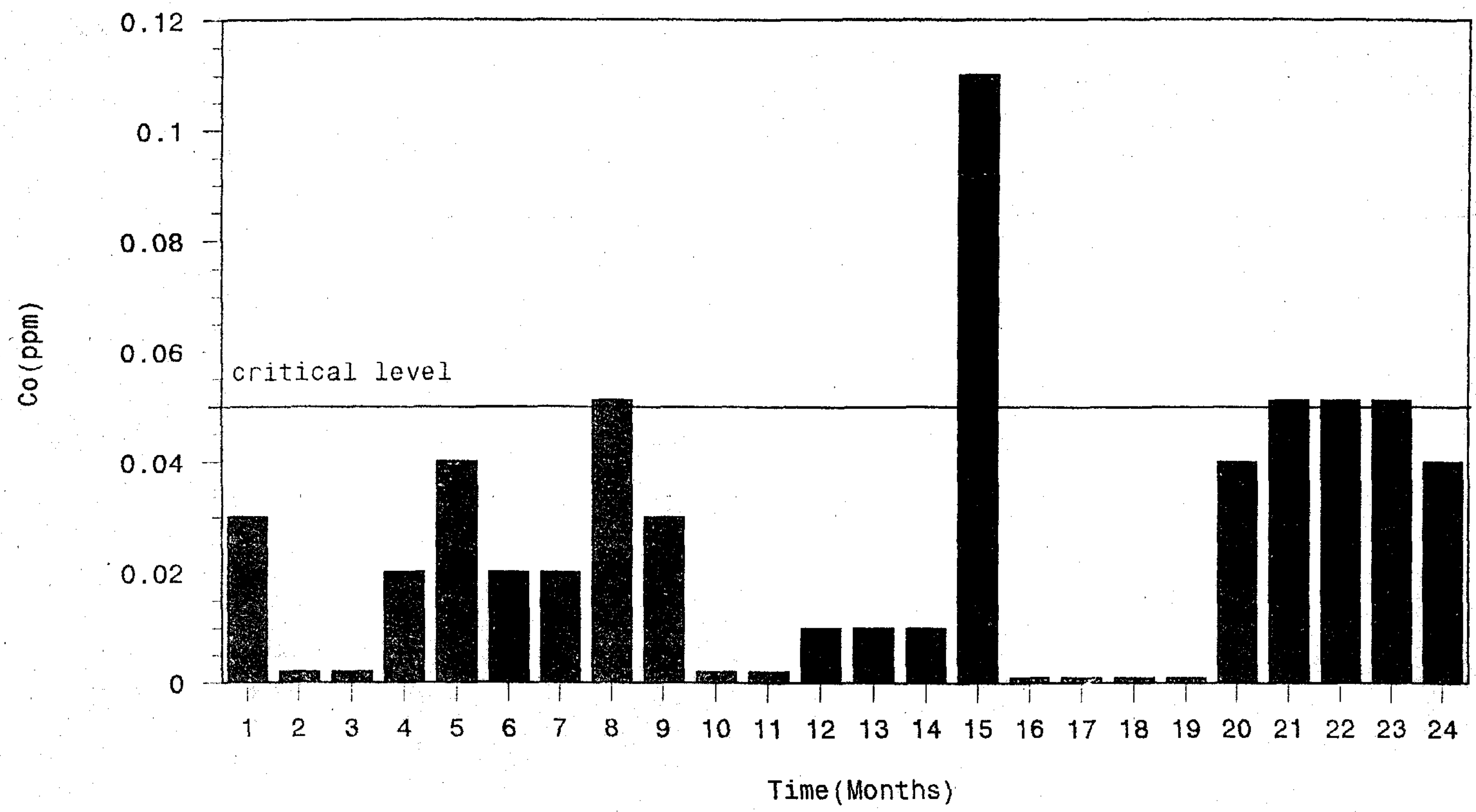

figure 11 : cobalt concentration in treated effluent as a function of time .