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STUDIES ON ACCUMULATION OF HEAVY METALS BY VEGETATIVE CROP (BRINJAL,TOMATO AND PATATO) PLANT PARTS.

*Punam Sadana and **Rajpal Tyagi

*Department of Chemistry,Maharaj Singh College, Saharanpur

**Department of Chemistry, M.M.College, Modinagar.

ABSTRACT

The studies was carried out on the absorption and accumulation of total heavy metals from nutrient solution of Zn , Cd of sub group II B and Pb of sub group IIA of periodic table and polluted river water by seeds of certain crop plants.ex. Brinjal, Tomato and Potato. Surface sterilized seeds of these crops were soaked in the 15 ppm,30 ppm and 45 ppm nutrient solution of heavy metals of IIB and IIA group of periodic table . ex . Zn,Cd and Pb as well as in 30% and 60% polluted river water . Simultaneously , a control set was run with seeds soaked in distilled water to assess the absorption and accumulation of total heavy metals in seeds . The seeds were sampled at 48 hrs, 96 hrs and 144 hrs. These soaked seeds were taken out from the experiments at each proposed hour, washed with distilled water and recorded dry weight material utilized for the quantitative estimation of total heavy metal content.

KEYWORDS : Heavy metals, Accumulation, Absorption, Vegetative Crops.

INTRODUCTION

Due to mining,industrial processing, use of various chemicals in agriculture etc. has lead to regional and global redistribution of metals in the environment creating pollution. The environmental concentrations of metals are much greater today than these were hundred years ago. Metal ions are phytotoxic in excess (Peterson[1], 1978) Nieboer and Richardson[2](1980) proposed that the term 'heavy metals' be abandoned in favour of a classification which separates metal ions into class A (Oxygen seeking), Class B (Nitrogen/ Sulphur seeking) and borderline (or intermediate). A survey of the co-ordination chemistry of metal ions in biological system (mostly X-ray crystallographic data) demonstrates the potential for grouping metal ions according to their binding preferences (i.e.whether they seek out O-,N- or S-containing ligands).This classification is related to atomic properties and the solution chemistry of metal ions. A convenient graphical display of the metals in each of the three categories is achieved by a plot of a covalent-bonding

index versus an ionic-bonding index. A review of the roles of metal ions in proposed classification for interpreting the biochemical basis for metal-ion toxicity and ions in toxicity studies.

The sophisticated analytical techniques developed over the past decade for the measurement of trace quantities of metal ions in biological tissues have provided biologist and chemists with powerful tools to assess the impact of industrial man on world ecosystems. An ever-increasing number of publications appear as the result of such studies and a great many include the term 'heavy metals' somewhere in the title. This term has found its way in to standard texts (eg Mahler and Cordes[3], 1966; Ochiai[4], 1977).The effect of a metal ion will depend not only on the kind of target organism but on many other factors including the conditions of administration , its availability and concentration and the mode and kinetics of uptake . In our brief summary of metal ion biochemistry , it was demonstrated that the particular binding centres in biomolecules , especially proteins and enzymes , satisfy the reactivity requirements of class A , or borderline ion . The requisite ligand types , as well as the size and geometry of the site presumably have been evolved to allow specific metals to occupy such binding centers . Occupation of such sites by unsuitable metal ion , or the binding of metal ion to reactive sites not normally requiring them , is often inhibitory . In this context Ochiai[4] (1977) has divided the mechanisms of metal – ion toxicity into the following three categories : (1) blocking of the essential biological functional groups of biomolecules , (2) displacing the essential metal ion in biomolecules and (3) modifying the active conformation of biomolecules . Thus , although metal ion toxicity is evidently complex , certain metal ion consistently include greater damage than others . Hence , it is possible to establish toxicity sequences . Heavy metals have played great roles in the genesis of present day civilization. In ancient time the wealth of emperors and kings was attributed to the possession of metals like iron , gold, silver, copper etc. in different forms. Still today, the dependence upon heavy metals has not decreased as these are very commonly used in agriculture , medicine, engineering etc. The magnitude of the danger of environmental pollution by heavy metals was probably for the first time realized with the Minamata disaster in Japan, where thousands of people suffered with mercury poisoning, after consuming the fish caught in Minamata bay. The bay got contaminated with mercury released from vinyl chloride plant between 1953 and 1960 (Smith and Smith[5], 1975). Similarly, it was also reported in Japan in 1955 that cadmium caused Itai-Itai Byo disease in human beings, mainly in women over forty. This was due to high level of cadmium in local foodstuffs attributable to irrigation water from the soil heaps of an abandoned mine. Minamata raised its ugly head once again, not in Japan this time, but in fishing communities of the Amazon rain forest (Pearce[6], 1999).

EXPERIMENTAL MATERIAL

ZINC Symbol Zn,Atomic Number 30,Atomic weight 65.38

Zinc is usually found in combined state although traces of metal in native state reported in the form of organo – metallic compounds . Zinc is extracted from its ores by Reduction process and Electrolytic process etc.

Compounds of Zinc

Zinc Oxide ZnO,Zinc Chloride $ZnCl_2H_2O$,Zinc Sulphate $ZnSO_2.7H_2O$

CADMIUM Symbol Cd,Atomic Number 48,Atomic Weight 112.4

Cadmium does not occcur free in nature . Most of the ores such as Calamine or Zinc Blender Contains Cadmium . A mineral Greenockite (CdS) is known but it is rare and has no importance of Cadmiferrous Zinc , the first product of distillation contains most of the Cadmium partly as oxide,Cadmium oxide CdO

CadmiumChloride $CdCl_2$,CadmiumCyanide$Cd(CN)_2$,Cadmium Sulphide CdS

Cadmium Sulphate $CdSO_4$

LEAD Symbol Pb,Atomic Number 82,Atomic Weight 207.21

Lead is very rarely native in volcanic regions . Small quantities of lead occur in Swedon . The chief ore of lead is Galena (PbS) . Ores of less importance are :

Cerrusite $PbCO_3$,Anglesite $PbSO_4$,Generkite PbO . $PbSO_4$ Leadhillite$3PbCO_3.PbSO_4$ Compounds of Lead Oxides of Lead Pb_3O_4.

Environmental pollution has become a serious problem at present.Emission , effluents and solid wastes from industries have increased the level of contaminants in air , water and soil to hazardous extent in many areas. Moreover , indiscriminate use of insecticides , herbicides , pesticides and other chemicals for plant protection and allied purpose have also led to their accumulation to damaging concentration in the organisms of upper trophic level .In the local area , effluents of certain industries are being discharged into city sewage drain . This water is being used for irrigation purpose of crops in several adjoining farms.Heavy metals have proved to be important pollutants , because of their non – biodegradable nature . It has been demonstrated that important heavy metal pollutants are Cu , Zn , Pb , Cd , As , Sb , and Hg etc . Effects of Pb,Cd and Hg on various biochemical processes have been reviewed by valle and Ulmer (1972) . present investigation therefore was undertaken to study the absorption and uptake of 3 heavy metals of II – B and II – A group of periodic table viz . Zn ,Cd and Pb with increasing atomic number and atomic weight and also uptake of total heavy metals[7,8,9] from polluted river waters In the following sections some of the salient finding of Experimental materials and heavy metal distribution , accumulation and uptake have been reviewed .

MATERIAL AND METHODS

Studies were carried out on the absorptions and accumulation of heavy metal from the nutrient solution of II-B Sub group particularly Zn , Cd and Pb (Sub group II-A) and also from the polluted river water by various excised organic of some road side vegetable crops such as Brinjal,Tomato and Potato of Solanaceae family.The estimation of total heavy metals, the digestion was done by concentrated nitric acid(Conc. HNO_3) an 60% perchloric acid($HClO_4$).Laterfrom the digest,in purified dithizone and estimated colorimetrically.(Sandell).

HEAVY METAL STOCK SOLUTIONS :

Three heavy metals Zinc , Cadmium (Sub group II B) and lead (Sub group II A) are utilized in our experimental work . Selection of these metals are based on previous trial work and also based on work of various workers.In our expriment Nutrient concentrations used are 15 ppm , 30 ppm and 45 ppm .Polluted water concentrations used are 30 per cent and 60 per cent .Side by side control distilled water socked plant part set also kept running in the experiment .In our experiment following salts were taken to prepare stock solution of these three metals .

Zn as $ZnSO_4.7H_2O$, Cd as $CdCl_2$,Pb as $PbSO_4$

The city of Saharanpur is located at the latitude of 29^0 28'N and at the longitude of 77^0 33'E . It has 27^0.8 meters altitude above the sea level. A small stream named DHAMOLA passes through the main city and carries all municipal waste etc which finally confluence with river Hindon near Tapri. The main roads run to towns of Behat and Chakrota in the North , Mohand and Dehradun to North-East ; to Roorkee and Hardwar in the East ; to Deoband and Muzaffarnagar in South – East ; to Rampur Maniharan and Delhi in the South ; to Nakur and Gangoh in South – West to Sarsawa and Ambala in West and to Chilkana – Sultanpur in North – West . Besides these main roads there are unmatelled roads join the city with Nagal , Jhabrera and Jarodapanda Villages . It is by the side of these roads vegetable crops are grown which is the subject of special observation and investigation in this study . These road side crop absorb the heavy metals and other nutrient from the effluents which is thrown along road side ditches by the over crowded industries running on almost all the main roads. The smoke and vehicles also create pollution.

RESULT AND DISCUSSION

Table1 show results with Brinjal seeds in the presence of higher doses of total heavy metal, there is promotion in the amount of total heavy metal per gram dry weight in seed tissue. Thus, in seeds of Brinjal soaked in 45 ppm solution of Zn, Cd and Pb total heavy metal content is 105.4%, 110.0% and 116.3% of control respectively at 48, 96 and 144 hours of soaking. Similar type of promotion are observed in 60% polluted river water concentration soaked seeds of Brinjal so the total heavy metal is 110.9%, 113.6% and 126.3% of control respectively at the same hours. Further, on unit weight basis, a decline in total heavy metal absorption and accumulation recorded in 15 and 30 ppm solution of Zn, Cd and Pb and also in 30% polluted river water concentration. Thus in 30 ppm solution soaked Brinjal seeds, total heavy metal content is 105.4%, 109.05 % and 115.4% of control respectively at 48, 96 and 144 hours. Likewise, total heavy metal content in Brinjal seeds soaked in 30% polluted river water are 108%, 113% and 122% of control respectively at the same hours.

TABLE 1 : EFFECT OF HEAVY METALS Zn, Cd AND Pb SOLUTIONS AND POLLUTED RIVER WATER ON FURTHER TOTAL HEAVY METAL (mg/g DRY WEIGHT) ABSORPTION AND ACCUMULATION BY SEEDS OF BRINJAL (LYCOPERSICON ESCULENTUS).

HOURS	CONTROL	EXPERIMENT A			EXPERIMENT B	
	ABSORBED FROM DISTILLED WATER	ABSORBED FROM SOLUTION			ABSORBED FROM POLLUTED RIVER WATER	
	0 ppm	15 ppm	30 ppm	45 ppm	30%	60%
0	0.110	0.110	0.110	0.110	0.110	0.110
48	0.110	0.114	0.116	0.116	0.119	0.122
96	0.110	0.118	0.120	0.121	0.125	0.125
144	0.110	0.125	0.127	0.128	0.135	0.139

Likewise, Table 2 shows that in soaked Tomato seeds tissues a similar increase and decrease in absorption and accumulation of total heavy metal noted. Thus, total heavy metal content in 45 ppm solution of Zn, Cd and soaked seed tissue is 113.7% , 127.1% and 149.3% of control respectively at 48, 96 and 144 hours. Similarly, in 30 ppm solution of Zn, Cd and Pb soaked seeds tissue total heavy metal is 111.3%, 121.5% and 125.3% of control respectively at the same hours. Results also indicate that the total heavy metal absorption and accumulation in tow polluted river water concentration also shows increased absorption level in total heavy metal level. Thus total heavy metal level in 30% polluted river water soaked Tomato seeds tissue is 110.75% 115.4% and 124.5% of the control respectively at same hours . Whereas, these values in 60% polluted river water soaked tomato seeds are 114.2%, 129.1% and 158.8% of the control respectively at the same hours. These results further support that increase in the level of metal in solution as well as in the level of metal in solution as well as in concentration of polluted river water causes increase in total heavy metal of tomato tissues under laboratory conditions.

TABLE 2: EFFECT OF HEAVY METALS Zn, Cd AND Pb SOLUTIONS AND POLLUTED RIVER WATER ON FURTHER TOTAL HEAVY METAL (mg/g DRY WEIGHT) ABSORPTION AND ACCUMULATION BY SEEDS OF TOMATO (LYCOPERSICON TOMENTOSA).

HOURS	CONTROL	EXPERIMENT A			EXPERIMENT B	
	ABSORBED FROM DISTILLED WATER	ABSORBED FROM SOLUTION			ABSORBED FROM POLLUTED RIVER WATER	
	0 ppm	15 ppm	30 ppm	45 ppm	30%	60%
0	0.3430	0.343	0.343	0.343	0.343	0.343
48	0.3430	0.356	0.382	0.390	0.380	0.392
96	0.3430	0.380	0.417	0.436	0.396	0.443
144	0.3430	0.387	0.430	0.509	0.426	0.545

In the same manner table 3 shows that in potato seeds tissue a similar type of increased rate of absorption and accumulation of total heavy metal take place. Thus, in 45 ppm solution of Zn, Cd and Pb the total heavy metal content in potato seeds tissue is 118.7%, 146.4% and 150% of the control respectively at 48, 96 and 144 hours.Likewise, total heavy metal level in potato seeds soaked in 30% polluted river water are 111,7%, 135.8% and 150.0% of the control respectively, at 48, 96 and 144 hours. However, these parameters are 127.3%, 148.4% and 154.6% of the control respectively at the same hours in 60% polluted river water soaked potato seed.

TABLE 3: EFFECT OF HEAVY METALS Zn, Cd AND Pb SOLUTIONS AND POLLUTED RIVER WATER ON FURTHER TOTAL HEAVY METAL (mg/g DRY WEIGHT) ABSORPTION AND ACCUMULATION BY SEEDS OF POTATO (SOLANUM TUBEROSUM).

HOURS	CONTROL	EXPERIMENT A			EXPERIMENT B	
	ASORBED FROM DISTILLED WATER	ABSORBED FROM SOLUTION			ABSORBED FROM POLLUTED RIVER WATER	
	0 ppm	15 ppm	30 ppm	45 ppm	30%	60%
0	0.128	0.128	0.128	0.128	0.128	0.128
48	0.128	0.146	0.149	0.152	0.143	0.163
96	0.128	0.172	0.178	0.183	0.174	0.190
144	0.128	0.189	0.190	0.192	0.192	0.198

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