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Research Paper Physics

Spectroscopic Study of Cadmium on the Growth of Amaranthus Dubius Linn

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ABSTRACT

A FTIR study was conducted to determine the effect of different concentration of cadmium on growth of Amaranthus dubius linn plants. The plants were raised in the pots containing the soil amended with various levels of cadmium (control, 10, 20, 30, 40 and 50mg/kg soil). The leaves and stems of Amaranthus dubius were collected at the various ages (30, 45, 60 day after sowing) with the different concentration (0, 10, 20, 30, 40 and 50mg/kg) of cadmium applied in the soil. The biochemical/organic constituents of plants sample were studied using FTIR. The extinction coefficient values (K) were calculated for the prominent absorption bands such as 3412, 2923, 1631 and 1321cm-1. The results revealed that cadmium treatments on plants exhibited lowest extinction coefficient value as compared to control.

KEYWORDS : FTIR, Amaranthus dubius, cadmium, extinction coefficient

INTRODUCTION:

With growth and development of industries, melting metals and consumption of heavy metals have been turned into a serious environmental problem (1, 2). Contaminant heavy metals including cadmium, chromium, copper, mercury, lead and nickel are defined as elements with metal properties and atomic number higher than 20 and density higher than 6g/cm^3 (2,3) . A high concentration of heavy metals in soil reduces biological activity and fertility of soils leading to yield reduction (4). Cadmium is one of the inorganic contaminant of public health interest due to its high toxicity after accumulation in the organs of the human body and aquatic lives (5, 6). In the present study, an attempt is made to study the effect of cadmium on Amaranthus dubius leaves and stems through an FTIR spectroscopic technique.

MATERIALS AND METHODS:

Amaranthus dubius seeds were planted in 3 kg of well mixed air dried soil placed in polyethylene coated earthen pots. The soil pH was 6.3. Cadmium in the form of cadmium sulphate was applied at the rate of 0, 10, 20, 30, 40 and 50 mg per kg of soil. The control leaves of Amaranthus dubius were collected at 30th, 45th and 60th day after sowing (DAS), the cadmium treated leaves were collected at 45th day and the stem samples were collected at 60days (harvest stage). The leaf and stem samples were dried in oven at 80ºC, ground to a fine powder and the FTIR spectra recorded using the KBr pellet technique employing a FTIR spectrometer in the region of 4000 – 600 cm-1.

RESULTS AND DISCUSSION:

The FTIR spectra of Amaranthus dubius leaves at different ages and cadmium treated in different concentration to soil presented in the figure .1 and figure .2. Figure 3 shows the FTIR spectra for stem of plants in various concentration of cadmium applied to the soil.

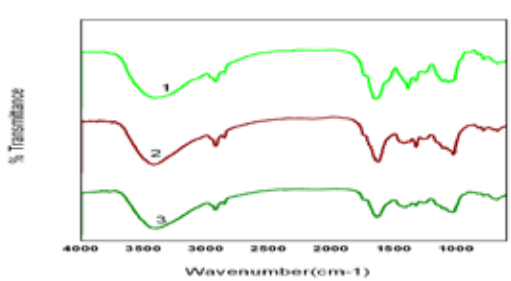

Fig. 1. FT-IR spectra of control greens leaves.
1 2, 3 – FT-IR spectra of control *greens* leaves analyzed at 30th, 45th and 60th DAS respectively.

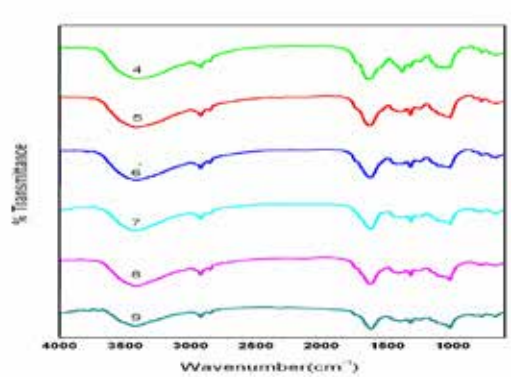

Fig. 2. FT-IR spectra of cadmium treated *greens* leaves.
4, 5, 6, 7, 8 & 9 – FT-IR spectra of *greens* leaves analysed at 45th DAS with cadmium application of 0, 10, 20, 30, 40 & 50 mg/kg respectively.

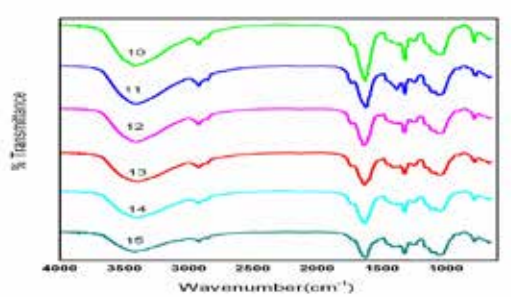

Fig. 3. FT-IR spectra of cadmium treated *greens* stems.
10, 11, 12, 13, 14, &15 – FT-IR spectra of *greens* stems analysed at 60th DAS with cadmium application of 0, 10, 20, 30, 40 & 50 mg/kg respectively.

The very strong absorption band observed around 3373 – 3422 cm^{-1} may be due to presence of bonded N-H/C-H/O-H stretching of amines and amides (7). The very strong broad absorption band at 3413 cm-1 shows the presence of O-H stretching (8). The presence of narrow sharp peak at~2924cm^{-1} and ~2853 cm^{-1} was assigned to C-H and C-H$_2$ (methoxy compounds) stretching vibration respectively (8). A symmetrical stretching of NO_2 group results in strong absorption band in the region of 1660-1625cm^{-1}. The observed absorption band at 1630cm^{-1} indicates the presence of amines (Proteins) (9). The observed peak around 1415 – 1421cm^{-1} in the plants may be due the presence of bonded C-O/O-H

bending (9). A medium peak at 1340 cm^{-1} due to CH_2 wagging collagen present in A. albicans (10, 11). A peak presented 1317 – 1321 cm^{-1} due to the C=N (amide 2) band components of protein collagen (11).

The medium band observed around 1240-1260 cm^{-1} in the plant may be due to presence of bonded C-O stretching (12). Many C-O-C groups exhibit characteristic bands in the 1150- 911 cm^{-1} spectral ranges and generally a strong band at 1026cm^{-1} is assigned to the vibration of C-O in alcohol hydroxyl group (13). The absorption band occurring at 723- 889cm^{-1} indicates the carbohydrates in the spectrum. The stretching vibrations assigned to the C-S linkage occur in the region of at 700-600cm^{-1}. The very week band occurring at 884 cm^{-1} shows a NH stretching vibrations, Nitrite group (14). The week absorption band at 780$cm^{-1}$and 620 cm-1indicates the presence of NH wagging and sulphates respectively (10).

In FTIR spectrum corresponding to all the leaves sample of absorption bands occur at 3413cm^{-1}, 2923cm^{-1}, 2854cm^{-1},1630 cm^{-1}1321 cm^{-1},1249cm^{-1},1106cm^{-1},1025cm^{-1},884$cm^{-1}$and 780cm^{-1}. In this study to estimate quantitatively the changes in the total organic constituents in the control and cadmium applied to soil. The extinction co-efficient (K) is the property of the material which defines the extent to which the material absorbs the energy. The spectral extinction co-efficient were calculated for the control at different ages and cadmium treated leaves of absorption bands at 3413cm^{-1}, 2923cm^{-1}, 1630cm^{-1} and 1321cm^{-1} given in table -1 & table 2 using the relation(15).

$K = DA/m$ cm^2/mg

Where D-optical density of the absorption band, log(Io/I); A- area of the pellet (cm2);m-mass of the samples in the pellet (mg);

Table .1; Extinction coefficient (K) values of prominent absorption bands for control greens *(A.dubius)* leaves at different sampling days

Spectrum number of Fig. 1.	Sampling days	Extinction coefficient 'K' (cm^2/mg)			
		Frequency (cm^{-1})			
		3413	2923	1630	1321
1	30	0.40	0.173	0.357	0.063
2	45	0.3998	0.139	0.315	0.0563
3	70	0.376	0.060	0.177	0.0256

Table .2. Effect of Cadmium on 'K' of prominent absorption bands for *greens* (*A. dubius*) leaves analysed at 45th DAS

Spectrum number of Fig. 2.	Cadmium applied in soil (mg/kg)	Extinction coefficient 'K' (cm^2/mg)			
		Frequency (cm^{-1})			
		3413	2923	1630	1321
4	0	0.399	0.139	0.315	0.0563
5	10	0.370	0.075	0.312	0.0543
6	20	0.361	0.067	0.244	0.0518
7	30	0.353	0.059	0.228	0.0475
8	40	0.332	0.050	0.223	0.044
9	50	0.283	0.046	0.208	0.0408

The spectral extinction co-efficient for the control and cadmium treated stem at 60th day of absorption bands at 3420, 2924, 1625 and 1324 given in the table -3.

Table 3. Effect of Cadmium on 'K' of prominent absorption bands for *greens* (*A. dubius*) stem analysed at 60th DAS

Spectrum number of Fig. 3.	Cadmium applied in soil (mg/kg)	Extinction coefficient 'K' (cm^2/mg)			
		Frequency (cm^{-1})			
		3420	2924	1625	1320
10	0	0.131	0..036	0.163	0.110
11	10	0.130	0.025	0.153	0.0645
12	20	0.125	0.021	0.138	0.0608
13	30	0.120	0.019	0.127	0.0469
14	40	0.118	0.016	0.125	0.0460
15	50	0.098	0.014	0.124	0.0431

Conclusion

The results from the table .1, the K value varies with the ages of the control plant. From the table .2 and table.3, decrease in the K value of all absorption bands even at low concentration of applied cadmium when compared to control. The reduction in extinction coefficient values may be due to reduction in the content of protein, amides, amino acids and fatty acids under cadmium treatment.

REFERENCES

1. Kuffner. M.M. Pushenreiter, G. Wieshammer M. Gorfer and A. Sessitch ,2008." Rhizosphere bacteria affect growth and metal uptake of heavy metal accumulating" willows. Plant soil. 304: | 35-44 | 2. Yan-de, J.H. Zhen –li and Y-Xiao, 2007. "Role of soil rhizobacteria in Phytoremediation of heavy metal contaminated soils". J. Zhejiang Univ. Sci., 8(3): 197-207. | 3. Hodson, M.E, 2004, "Heavy metals –geo chemical bogey men?. J. Environ. Pollution. 129:341-343. | 4. Babek Moteschare zadeh, Gholam Reza savaghebi –Firozabadi, Hossein Ali Alikhani and Hossein Mirseyed Hosseini ,2008. "Effect of Sunflower and Amarantlues culture and Application of Incoulants on Phytoremediation of the soils contaminated with cadmium". J. Agric. & Environ. Sci .,4 (1); 93-103. | 5. Kumar M. Rathore D P S and Sing A.K ,(2000). "Toxic effect of heavy metals to human and environments". Talanta 51: 1186-1187. | 6. Okorp I.A abd Abli T, 2011. "Sorption models of Cadmium (11) ion onto edible fruit wastes", Ameri. J. Scienti. And Indus. Resear., 2(3): 386-390. | 7. Mohan.J, 2001.Orgnic Spectroscopy- Principle and Applications, Nasrosa Publishers, New Delhi. | 8. Mitali Konwar and G.D. Baruah, 2011. "On the nature of the vibrational bands in the FTIR spectra of medicinal plant leaves". Arhieves of Applied science Research. 3(1):214-221. | 9. S. Muruganatham, G. Anbalagan and N. Ramamurthy 2009, FTIR and SEM-EDS comparative Analysis of Medicinal Plants, Eclipta Alba Hassk and Eclipta Prostrata Linn. Romanian J. Biophys, vol 19 No.4, P285-294, | 10. Eckel. R, H. Huo, H. W. guan, X.Hu, X- Che, W.D. Huang, 2001."Characteristics Infrared spectroscopic patters in the protein bands of human breast cancer tissue. Vibrational spectroscopy 27, 165-173. | 11. J. komal kumar and A.G. Devi Prasad, 2011' indentification and comparisons of Biomolecules in medicinal plants of Tephrosia Tinctoria and Atylosia Albicans by using FTIR Romanian J. Biophy. Vol121: No:1 63-71. | 12. Valchosr. N, Y. Akopelitia, M.Psaroudaki, V. Konstantinidou, A. Chatzila zarou, E. Tegou, 2006. "Application of fourier transorm-infrared (FTIR) spectroscopy to ebile oils. Analytica chemica Acta. 573/574.459-465 | 13. Cavalu, Simona, Simona Cinta Pinzaru, 2005, "Qualitative and quantitative aspects in analysis of ginseng Pharmaceuticals using vibrational spectroscopy. Romanian J. Biohys. , 15: 61-66. | 14. L.J. Bellany 1954, Infrared spectra of complex molecules, Methuxen, London PP (1-323). | 15. Velmurugan.S, 2006. "Spectroscopic studies on the status of redroot disease incidence and its variation in sugarcane (saccharum officinarum L), Ph.D. Thesis, Annamalai University, Annamalainagar, India. |