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ELECTRO KINETIC ENHANCED PHYTOREMEDIATION OF ASA AND APAP BY *ORYZA SATIVA L.* PLANTS

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ABSTRACT:
Electro Kinetic Enhanced Phytoremediation (EK-PR) technique is one of the reliable and efficient procedure for the phytoremediation of pollutants from aqueous medium. The scope of this method is evolving in the present scenario as remediation of pollutants becoming a challenging task. EK-PR can be coupled with variety of plants including hydrophytic and non-hydrophytic plants. In the present study modified EK-PR is coupled with Oryza Sativa L. plants (paddy plants) to remediate Acetyl Salicylic Acid (ASA) and APAP (Acetyl Para Amino Phenol) from aqueous solution. 11^{th} leaf paddy plant absorbs 6.1% more APAP and 3.1% more ASA compared to the plant incubated under 24 hours of normal conditions under EK-PR method.

EK-PR (Electro Kinetic Enhanced Phytoremediation) is a bio electro restoration technique strategically designed and developed for in situ treatment of contaminated soils. The combination of EKR (Electro Kinetic Remediation) and phyto remediation enhances the effectiveness of remediation process and overcome the limitations of phyto remediation. (Hodko et.al., 2000; Bedmar et.al., 2009). This process involves action of electrolysis using low intensity electric field potential and phyto absorption of contaminants from soil. EKPR consists of application of low intensity electric field in the vicinity of plant grown in the contaminated soil.

Effects of Electric field on plants characteristics was reported first by Lemstorm (1904). He stated that plants tolerate electric field, stay greener and shows an increase in yield. This experimental finding inspired to develop newer strategies of combining EKR with phytoremediation for effective environmental restoration. In the EK-PR cleaning up process of contaminants performed by plants and this process is enhanced by electric field by increasing bioavailability of contaminants.

Factors affects the efficiency of EK-PR are;

1) Use of AC/DC current
2) Voltage level
3) Frequency of voltage (continuous or periodic)
4) pH level of soil/water
5) Addition of Facilitating/ Chelating agents

In the EK-PR technology, due to applications of electric field which effectively brings large amount of soluble heavy metal ions towards plant's root system, this sometimes result stress conditions for the plants. Thus plants with high tolerance level and hyper accumulating capacity are selected for EK-PR application (Bedmar et.al., 2009).

EK-PR of ASA and APAP by *Oryza sativa L.:*

11^{th} leaf paddy plants were obtained from armoor agricultural fields and each plant was hydroponically incubated in 100ml beaker containing 50ml (0.3mg/mL) of aqueous solution of ASA and APAP for 24 hours. Plants were incubated under 10hrs/ Day fluorescent light and all the test conditions were maintained at27 $\pm 1^0$C .The application of a continuous DC electric field with voltage drop of 1 V was applied. The electric current was only used for 6 hour. Paddy plant was arranged close proximity to cathode (plants surrounds cathode) and anodes placed away from plants.

Observations were made after 24 hrs of incubation and focused on quantitative analysis of APAP and ASA absorption by plants under electric stimulation was determined by spectrophotometric method.

RESULTS AND DISCUSSIONS:

Maximum Absorption of APAP and ASA were determined in plants incubated under electric stimulation compared to the control plants which incubated normally without electric stimulation. The quantity of APAP absorbed by *Oryza sativa L.* (11th leaf plant) incubated in Electro-stimulation conditions was significantly increased by 6.1% compared to the plant incubated under 24 hours of normal conditions. Whereas the increase was 3.1% in case of absorption of ASA by 11th leaf *Oryza sativa L.* plant. (Table.1.).

Table 1. Absorption of ASA and APAP by 11th leaf paddy plant after 24 hrs of Drug incubation under Normal and EK-PR conditions.

S.No.	Phyto-remediation Condition	Drug Treatment	Concentration of Absorbed Drug (in mg)	Percentage of Absorption
1	Normal(CONTROL)	ASA	2.000±0.264	13.334
2	EK-PR	ASA	2.467±0.338	16.447
3	Normal(CONTROL)	APAP	5.563±0.364	37.087
4	EK-PR	APAP	6.480±0.375	43.200
values are mean ± S.E(n=3)				

The increased absorption by plant under EK-PR was due to enhanced migration of ionized drug molecules in aqueous solution by electro stimulation.

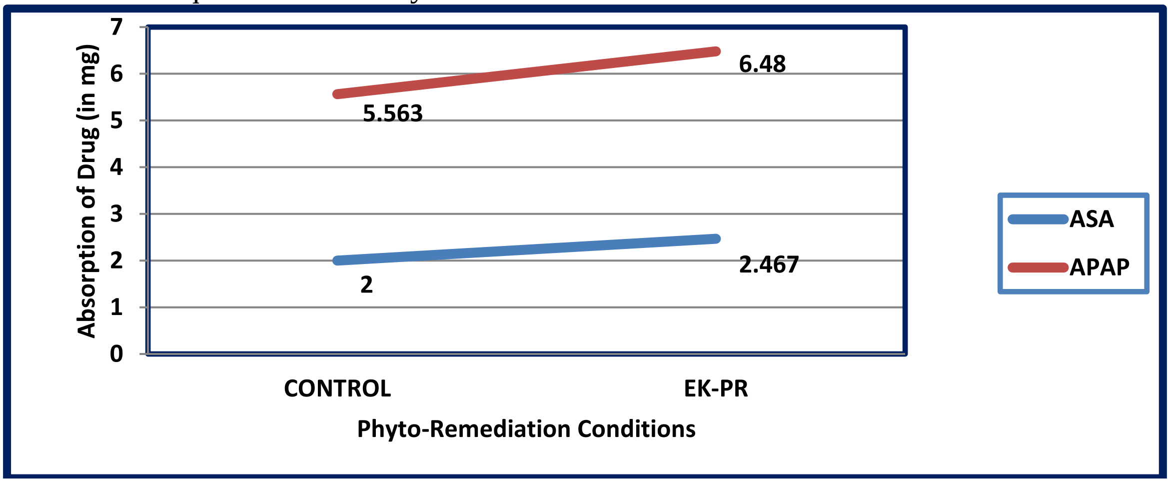

Fig. 1. Impact of Electro-stimulation on drug absorption by paddy plant.

CONCLUSION:

Absorption of Drugs by plants from their aqueous solutions was greatly increased by Electro-stimulation. ASA and APAP get ionized in aqueous solution and moves faster due to electro-stimulation. This might enhance probability of interaction of drug molecules and root system which leads increased absorption. The application of this knowledge in remediation of other highly toxic organic pollutants will be helpful to redesign the phyto-remediation approaches.

ABBREVIATIONS:

ASA: Acetyl Salicylic Acid (Aspirin),
APAP: Acetyl Para Amino Phenol (Paracetamol),
EK-PR: Electro Kinetic Enhanced Phytoremediation.

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