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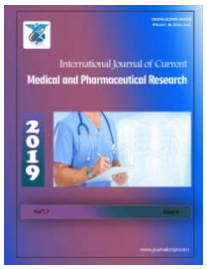

Research Article

ELECTRO CHEMICAL STUDY OF XEROPHYTIC MEDICINAL PLANT DHATURA METEL

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ABSTRACT

The study of xerophytic medicinal plants Dhatura metel-L of Solanaceae family have been performed electrochemically in vitro conditions in rainy, summer, and winter seasons. Various constituents of bio-sap such as pigments chlorophyll free amino acids have been analysed chromatographically and documented. The bio-electrode potential (BEP) regulating several vital physiological processes in plants was measured and graphed to co-relate the results. The effects of catalyst, respiratory substrate and neutral salts have been examined. The origin of BEP produced in light of charge transfer complex was discussed.

INTRODUCTION

Electro chemistry deals with the chemical changes and the electrical energy produced at the boundaries between electrolytes and electrodes and bio-sap of the leaves of the plant supports medicinal world in understanding medicinal relevance of plant.

India has been recognised as a paradise for medicinal plants[1-6] in global arena. A large number of plants have been used by Aurvedic and unani practitioner of China, Egypt and Greece even in India as medicines. Plants have been playing a vital role in providing materials as a food for human and animal's body. The ancient Indian documents and the Vedas emphasize planting of trees for worshipping materials, prosperity fulfilment of desires and salvation to ensure themselves against all diseases for generations to come. Dhatura metel-L is found in tropical and subtropical regions throughout India. The flowers and fruits are often offered to Lord Shiva. It belongs to toxic group.

The bio-electrode potential occurs from various sources of plants excitable stimulicells due to existence of moving ions through membranes[7] permeability by action of energy consuming pumps. The redox couples present in the system are solely responsible for generation of small BEP through enzyme catalysed reaction.[8]

In last two decades, a number of electrochemists exploited bio-mass energy from the xerophytic plants non-conventionally and developed leaves batteries based on charge transfer complexes. The recent literature reveals that no information on above work is available hence we report here the results of electrochemical study of xerophytic medicinal plants Dhatura metel-L.

Experimental

Dhatura metel-L is a xerophytic plant belongs to Solanaceae family. This is also called as thorn apple. It is grown in sub-tropical and tropical areas found all over in India. The height lies between 2-5feet with flower 5-6 inch. It has a rough surface area with lucrative ions. The three varieties of this medicinal plants abbreviated as DT_1, DT_2, and DT_3 have been studied electrochemically using three pairs of electrodes Ag-Zn, Cu-Zn and C-Zn of dimension 2.5 × 2.5 cms in which C (block) electrode of 2.5 cms and Zn 2.5 cms were used in different seasons respectively. The electrodes were processed well before use.

All the chemicals and solvents used in the investigation were of analytical grade. The bio-mass was isolated after performing various preliminary processes such as plucking of leaves, crushing and extraction from DTA system. The Phyto-constituents of DT_1, DT_2, and DT_3 was obtained by extracting with CH_3OH separately. The extract was dried under vacuum and volume was reduced to 5.00 ml prior to ascending paper chromatographic anaysis[13,14]. The R_f values of pigments and

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amino acids the experimental materials under a flow of Nitrogen as at specified conditions of temperature and relative humidity was determined. The other physical parameters such as pH, conductivity etc. were also measured by sophisticated instruments.[15]The bio-emf-cell is constructed by sandwiching the injured leaf (DT) between two electrodes in vitro condition. The electrical measurement, have been performed by a Panel meter with an accuracy of $\pm$ 0,1% DC current.

The BEP has been measured several times under normal atmospheric conditions in Winter (W), Summer (S), and Rainy(R) seasons at fixed regular time. Various graphs were plotted between BEP and time.

RESULTS AND DISCUSSION

The maximum potential development in injured xerophytic medicinal plants for DT_1 -1133 mV (S), DT_3 – 1080 mV (W), and DT_2 – 1071 mV (R), in night with electrode pair Ag-Zn and minimum was observed for DT_3 – 791 mV(S), 807 mV (R), and 838 mV(W) in morning under vitro condition, with Cu-Zn and Ag-Zn pairs of electrodes respectively.

The total voltage (BEP) delivered by medicinal plants in three different seasons with a time duration 144 hours have been recorded in Tables: 1 to 3 and BEP versus time graphs plotted (Figs. 1 to 3).

1. The study indicates that electrodes pair Ag-Zn extracts maximum (BEP) 13257 mV (W) from DT_1 and minimum 8763 (S) by DT_3.
2. The maximum BEP was delivered as 11015 mV (R) by DT_2 whereas minimum BEP 7584 mV (S) was obtained from DT_3 with C-Zn electrodes pair.
3. The lowest BEP was extracted by Cu-Zn electrode pair as 6064 mV (S) from DT_3 in time duration 128 hours whereas the pair of electrodes, computed total delivered BEP 11811 mV (W) in a time span of 144 hours. The BEP vs. time graphs drawn in three seasons with three pairs of electrodes indicate that there is periodic steep down asymptotically fall of potentials.

The $CuSO_4 \cdot 5H_2O$ used as a catalyst was operative factor found to retard the BEP due to de-activation effect of physiological activities of the tissues having activities like photosynthesis etc. The electrons contributed from oxidation and reductions occurring at the surface of the leave developed maximum BEP in 72 hours for DT_3 (878 mV) with Cu-Zn electrode pair in winter and minimum was observed by DT_2 (281 mV) with C-Zn electrode pair in rainy season.

The glucose ($C_6H_{12}O_6$) exhibits the role of respiration and delivered more charges within same span of time (72 hours) but Later on BEP stabilizes soon showing no more change in BED. The highest BEP developed for DT_1 (937 mV) with Ag-Zn electrode pair in summer and minimum was found by DT_3 (578 mV) with C-Zn electrode pair in winter season respectively.

The effect of primary salts (NaCl and KCl) have shown promising effect in development of BEP when studied within same duration of 72 hours. The anions and cations of neutral salts are absorbed/ penetrated more rapidly in multi layers of plants than di- and trivalent ions, enhance the ionic transport contribution during charge transfer reaction occurring in the system consequently give rise high voltaic output.
The highest BEP was developed for DT_1 (1103 mV) of KCl with Ag-Zn (S) electrode pairs in 72 hours whereas lowest was found for DT_2 (601 mV) with C-Zn electrode pairs in rainy season.

Based on BEP the order of activity was observed in following sequence:

$$DT_1 > DT_2 > DT_3$$

The above order of bio-activity is supported by various operative factors such as age of plant's leave, temperature, nature of injury, moisture, pH and conductivity, photosynthesis, and nature of electrodes etc. causes variation in potential.

The swelling and shrinking of chloroplast takes place during ATP synthesis caused by photosynthesis which is electrochemical in nature and develops electrical potential across the membrane.[16] which is more permeable for ion movements.

During photic excitation loss of electrons occur from chlorophyll which lead energy transformation in to ATP and causes reduction of NADP to NADPH. The biomass contains Zwitter ions of amino acid solely responsible for redox process for flow of current. The numerous fuel cells of plants containing uni and multi layers of oppositely charged ions between sap and electrodes form an electrical double layers during adsorption which cause development of bio-potential. The younger leave cells neither obstruct the physiological process nor reduce the electrical conductance, whereas older cells hinder and reduce the ionic potential. The water has the greatest conductivity. The consumption of oxygen has direct effect on the enhancement of power output.

The injured leaves give rise high BEP rather than uninjured leaves as it has no hindrance of cuticle for free movement of ions towards the site of injured portion for healing process and them higher potential is produced. Regular BEP is obtained from fuel cell as long as tissues are existed in the system.

In present work the tissues has to fight for maintenance of live activities i.e. struggle for survival as detached leaves loose its supply of water and causes shivering effect over potential drainage during transpiration. In xerophytic medicinal plants, it is crystal clear that chemical reaction increases by heating and slowed down by cooling. The rains make the transport phenomenon more pronounced which is responsible for high BEP because the moisture may probably results in enormous reduction of internal resistance.

The fluctuations in BEP is maximum in rainy season whereas minimum in summer season. At high temperature, more transpiration occurs so the bio-mass of the leaf contains ions also get dry. In morning hour, photo synthesis begins and mesophyll cell of leaf get activated. In winter season, highest potential is observed at noon whereas lowest in the morning, because of low temperature in morning and at midnight the ions present become inactivate.

The maximum BEP was given by Ag-Zn pair of electrodes. Ag belongs to coinage metal where Zn is a transition metal. The Ag has a tendency to gain electrons from sap is more pronounced than Cu and Zn etc. When bio system is suddenly killed or de-activated it tries to achieve the thermodynamic equilibrium and thus null potential is obtained asymptotically under such environmental condition, the number of tissues are very much sensitive to ambient atmosphere.

Table 1 Bio-electrode potential (BEP) time duration of Xerophytic medicinal plants

Xerophytic medicinal plants : Dhatura metel-L (DT_1)
Electrode pairs: Ag-Zn, C-Zn, and Cu-Zn
Temp.: 306 K
Season: Summer (S)

S. No.	Time (Hours)	BEP (mV) Electrode pairs		
		Ag-Zn	C-Zn	Cu-Zn
		(1)	(2)	(3)
1.	0	959	916	870
2.	8	970	932	881
3.	16	852	846	803
4.	24	873	823	796
5.	32	830	745	660
6.	40	851	759	672
7.	48	822	681	553
8.	56	829	709	574
9.	64	718	594	497
10.	72	735	621	523
11.	80	517	468	352
12.	88	545	461	367
13.	96	392	308	272
14.	104	407	321	287
15.	112	344	247	148
16.	120	217	197	122
17.	128	212	182	48
18.	136	110	47	17
19.	144	78	50	0
20.	152	0	0	0

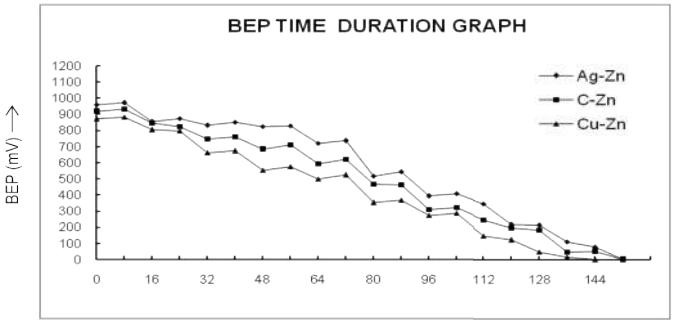

Fig.1
Plot of BEP vs. Time
Xerophytic medicinal plant : Dhatura metel-L (DT_1)
Temperature : 306 K ; Season : Summer (S)

Table 2 Bio-electrode potential (BEP) time duration of Xerophytic medicinal plants

Xerophytic medicinal plants : Dhatura metel-L (DT_2)
Electrode pairs: Ag-Zn, C-Zn, and Cu-Zn
Temp.: 301K
Season: Rainy (R)

S. No.	Time (Hours)	BEP (mV) Electrode pairs		
		Ag-Zn	C-Zn	Cu-Zn
		(1)	(2)	(3)
1.	0	970	915	869
2.	8	1007	932	834
3.	16	866	1021	799
4.	24	882	943	761
5.	32	780	927	710
6.	40	802	847	709
7.	48	671	735	595
8.	56	700	651	550
9.	64	598	555	492
10.	72	610	648	498
11.	80	480	556	437
12.	88	463	560	331
13.	96	415	465	300
14.	104	309	398	197
15.	112	199	306	141
16.	120	145	245	92
17.	128	88	198	42
18.	136	0	113	0
19.	144	0	0	0

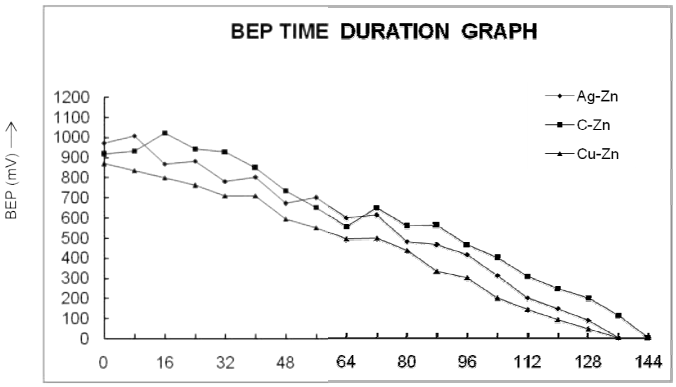

Fig.2
Plot of BEP vs. Time
Xerophytic medicinal plant : Dhatura metel-L (DT_2)
Temperature : 301 K ; Season : Rainy (R)

Table 3 Bio-electrode potential (BEP) time duration of Xerophytic medicinal plants

Xerophytic medicinal plants : Dhatura metel-L (DT_3)
Electrode pairs: Ag-Zn, C-Zn, and Cu-Zn
Temp.: 289K
Season: Winter (W)

S. No.	Time (Hours)	BEP (mV) Electrode pairs		
		Ag-Zn	C-Zn	Cu-Zn
		(1)	(2)	(3)
1.	0	838	890	885
2.	8	830	873	796
3.	16	849	803	891
4.	24	831	862	765
5.	32	812	750	780
6.	40	759	719	655
7.	48	790	703	750
8.	56	745	660	608
9.	64	614	507	582
10.	72	656	520	400
11.	80	521	422	333
12.	88	470	385	296
13.	96	494	388	215
14.	104	431	212	285
15.	112	165	113	109
16.	120	80	77	44
17.	128	43	40	0
18.	136	0	0	0

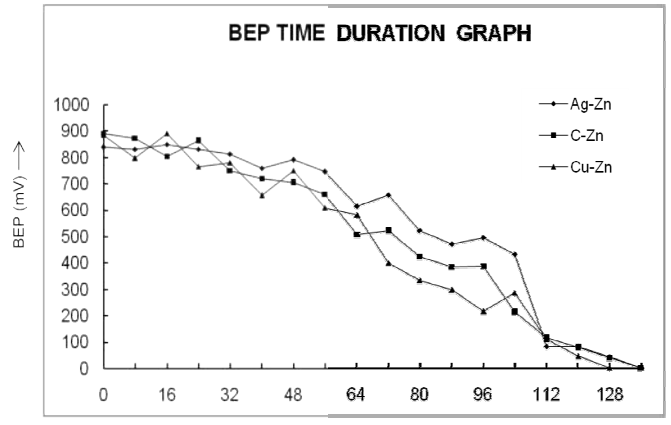

Fig.3
Plot of BEP vs. Time
Xerophytic medicinal plant : Dhatura metel-L (DT_1)
Temperature : 289 K ; Season : Winter (W)

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