WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 7, 1170-1178. Research Article ISSN 2277–7105

STUDY ON EFFECTS OF PULSED MAGNETIC FIELD ON BIOCHEMICAL PARAMETERS OF HORDEUMVULGARE (BARLEY) SEEDS

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Article Received on
12 February 2025,

Revised on 04 March 2025,
Accepted on 24 March 2025

DOI: 10.20959/wjpr20257-36113

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ABSTRACT

Agriculture is the means of livelihood of about two-thirds of the work force in India. Of late the production and area under pulses cultivation in the country has stagnated. On the other hand, the exponential growth of population needs higher production to meet the required demands. The techniques and methods to increase and improvise the yield of a variety of seeds are being conducted. The present work is an attempt to study the effect of pulsed magnetic fields on the biochemical parameters of *Hordeumvulgare* (Barley) seeds. 50 g of dry barley seeds were exposed to Pulsed magnetic field of intensity of 1500 nT and varying frequencies of 100, 500, 1000 Hz; sine waveform for 5 h per day for a period of 15 days. The seeds were exposed to PMF in dry condition. It was seen that the pulsed magnetic field enhanced the biochemical parameters of the test (Exposed seeds) *Hordeumvulgare* seeds as compared to the control (Unexposed seeds). The maximum increase of mostly all biochemical parameters was observed in the sample Test 3 i.e., at frequency of 1000 Hz. Hence, this method can be used to increase the quality and yield of a seeds. This method might also provide a feasible eco-friendly solution for seed.

KEYWORDS: *Hordeumvulgare;* Biochemicalparameters. Pulsed magnetic field; Bioelectromagnetics.

INTRODUCTION

The origin of our knowledge of Magnetism has been lost in antiquity, only vague reference being available during years of the Christian era. It is claimed that Chinese scholars were aware of the mysterious property of Magnetism as early as 1600.Scientist's interest in magnetism got a further focusing with the book "DeMagnete" by William Gilbert of England in 1600 A.D., according to which earth itself is a giant magnet having the closest conceptual approximation to a magnetized sphere.[1] As long ago as 1769, Lomonosov suggested "Discourse on Greater Accuracy of Marine Navigation", that the terrestrial globe consists of differently magnetized bodies and hence is magnetized non uniformity.[2]

Magnetic Field can be characterized by the force they exert on a moving charge or on an electrical current. Magnetic field is a vector quantity that is characterized by both magnitude and direction. Electrical currents are sources of magnetic fields. The uniformity of a magnetic field depends on the nature and proximity of the source, just as the uniformity of an electric field does. Magnetic fields generated by transmission line are quite uniform over distances of a few meters near the ground. However, for small sources such as appliances, the magnetic field decreases rapidly over distances comparable with the size of the device. Magneto Biology is the study of interaction of magnetic fields with in the living tissue and its influence on life process. It is the new multidisciplinary field that approaches radiobiology of non-ionizing radiation. It is the line of investigation in Biophysics that studies biological effects of mainly weak static and low frequency magnetic fields, which do not cause heating of tissues. It corresponds to somewhat more general term bioelectromagnetics, which should not be mixed up with the term bio electromagnetism. It is rapidly developing new technology in the area of medical treatment by the use of relatively weak electromagnetic fields that exerts just informational influence on the organism. Michael Faraday of England is regarded as the founder of magneto chemistry. He based his investigations on the early research of Ampere, Oersted, Arago and Biot. He showed that all matter is magnetic in one sense or the other i.e., all matter is either attracted or repelled by a magnetic field. He may also be regarded as one of the founding fathers of Electromagnetism. PMF stands for both Pulsed Magnetic Field and Pulsating Magnetic Field. Magnetic field varying with time in a rhythmic manner usually generated by pulsed electric currents flowing through coils is called a PMF. Static Magnetic Field: A simple bar magnet has got the magnetic lines of force travelling from its north (N) pole to its south (S) pole. If in the place of a magnet, we have a coil of wire carrying a Direct Current (DC) from a battery. With an Alternating Current (AC) generator in the place of a

battery, we have a current surging forward and backward in the coil windings generating a magnetic field surging back and forth in the coil along its axis.[3]

METHODOLOGY

The pulsed magnetic field (PMF) used in the experiments were generated in a specially fabricated Controlled magnetic Field (CMF) enclosure (Fig. 1). The 3 member coil system of the CMF enclosure, designed after the primary equations of Fansleau and Braunbeck, is made up of two sets of circular coils the inner two is being of large diameter and the outer two are of smaller diameter, all the four being mounted co- planar and co- axial. The four coils are wound with the same number of turns of enamelled copper wire, all the coils being electrically connected in 'series-aiding' configuration. The ratio of the diameter of the two sets of coils and also the separation (or spacing) in between them are so adjusted that the entire disc - shaped volume between the inner (larger) coils offers the most uniform (ie. Homogenous) magnetic field.

Exposure details

50g of barley seeds are taken in 3 packets. The seeds are exposed to pulsed magnetic field of frequency [T1- 100 Hz, T2 - 500 Hz, T3 - 1000 Hz] with intensity ±1500 nT, current of 30mA using sine wave for 5h duration per day for a period of 15 days. Seeds without exposure to pulsed magnetic field served as control. The seeds exposed to PMF are in dry condition.

Control - Seeds not exposed to magnetic field

Test 1(T1) - Seeds exposed to 100 Hz

Test 2(T2) - Seeds exposed to 500 Hz

Test 3(T3) - Seeds exposed to 1000 Hz

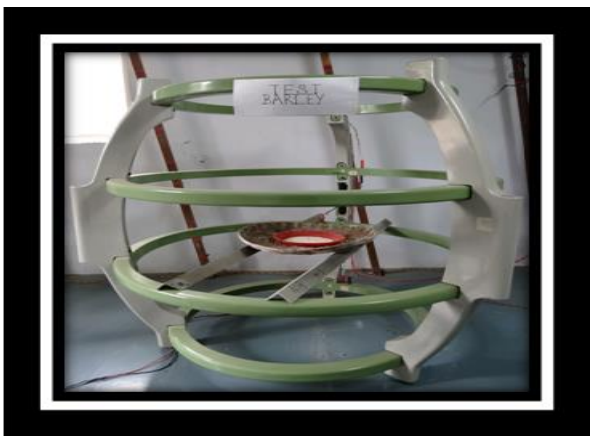

Fig. 1: Barley exposed to PMF.

Estimation of total proteins

Taken graded volumes of working standard in the range of 0.2, 0.4, 0.6, 0.8, and 1.0 ml in a series of test tubes marked as S1 to S5.0.4 ml of the extracted sample was taken in the test tubes and made up to 1 ml with distilled water. 4.5 ml of alkaline copper reagent was added to all the test tubes and was kept for incubation for 10 min. A blank with 1 ml of distilled water and 4.5 ml of alkaline copper reagent was taken. 0.5 ml of FolinCiocalteau reagent was added to all the test tubes. Incubated the test tubes for 20 min. The blue colour developed was read at 640 nm using spectrophotometer. A standard graph was drawn by plotting the concentration of the protein in the X-axis and the optical density in the Y-axis. From the graph, the amount of total proteins present in the Hordeumvulgare seeds was calculated.[4]

Estimation of carbohydrates

Graded volumes of standard solution were taken in the range of 0.2, 0.4, 0.6, 0.8, and 1.0 ml in the test tubes marked from S1 to S5. A blank was maintained simultaneously with 1.0 ml of distilled water. 0.5 ml of test samples was taken in the test tubes marked T1, T2 and T3.

0.5 ml of control sample was taken in a test tube marked as C. All the test tubes were made up to 1 ml with distilled water. 4.0 ml of anthrone agent was added to all the test tubes and was kept at room temperature for 10 min and cooled. The colour developed was read at 620 nm using a spectrophotometer. A standard graph was drawn by plotting the concentration of glucose in the X-axis and the optical density in the Y-axis. From the graph, the amount of carbohydrate present in Hordeumvulgare was calculated.[5]

Estimation of total aminoacids

Working standard solution was taken in the range of 0.2, 0.4, 0.6, 0.8 and 1 ml in a series of test tubes, marked as S1 to S5 respectively and made up to 4 ml with distilled water. 0.5 ml of the test solution was taken and made up to 4 ml with 3.5 ml of distilled water. 4 ml of distilled water was maintained as a blank. 1 ml of ninhydrin was added to all the tubes. The mixture was kept in a boiling water bath for 10 min and was cooled down to room temperature. 1 ml of 50% ethanol was added to all test tubes and was kept for 5 min incubation. The bluish violet colour developed was read at 575 nm using spectrophotometer. A standard graph was drawn by plotting the concentration of Amino acids on the X-axis and the optical density on the Y-axis. From the graph, the amount of total amino acids of Hordeumvulgare was calculated.[6]

Estimation of nucleic acids

Different volumes of DNA solution was pipette out in different test tubes marked as S1 to S5. The final volume was made up to 1 ml with distilled water. 1 ml of test sample and the control sample was taken in test tubes.Blank was set up with 1 ml of distilled water. 5 ml of diphenylamine was added to all test tubes.It was mixed well and heated in a boiling water bath for 10 min. The optical absorbance was measured at 595 nm through the spectrophotometer. A standard graph was drawn by plotting the concentration of the DNA on the X-axis and the optical density on the Y-axis. From the graph, the amount of DNA present in the Hordeumvulgare seeds was calculated.[7]

Estimation of RNA

Taken graded volumes of 0.5 to 2.5 ml of sample standard solution in test tube marked as S1 to S2.0.5 ml of the sample was taken as test and control and it is marked as T1, T2, T3 and C.A blank was set by taking 2.5 ml of saline in all the test tubes. All the test tubes were then made up to 2.5 ml with saline. Then added 3 ml of Orcinol reagent to all the test tubes, mixed well and kept in a boiling water bath for 15 min, cooled and the green colour developed was read at 665 nm. A standard graph was drawn by plotting the concentration of the RNA on the X-axis and the optical density on the Y-axis. From the graph, the amount of RNA present in the Hordeumvulgare seeds were calculated.[8]

RESULTS AND DISCUSSION

During development plant convert physical and chemical signals (Example: light, gravity and phyto hormones) into specific growth responses. The pathway for these environment or physiological studies leads to a new development program involving biochemical and molecular changes in the cells. The magneto biological studies have revealed an important mechanism of response to the electromagnetic field by living organisms is the changes in the permeability of biological membranes. Biological membranes are the structural elements of any cell, which are mainly responsible for the maintenance of functions and for the fine regulation of all organs.

Even though there are several adverse effects of magnetic field on living organisms, present study is concentrating on the beneficial effects on the living organism, which is encouraged. In the plants, the Pulsed Magnetic Field can be used for the crop development to increase both the quality and quantity of the crop. Seeds represent a package containing a living organism capable of exhibiting almost all processes found in the mature plant such as

respiration, cell division, morphogenesis and photosynthesis. In the present investigation an attempt has been made to study the treatment of dry barley seeds to continuous exposure of pulsed magnetic field and its effect on biochemical parameters at intensity 1500 nT, wave form sine wave and frequencies of 100, 500, 1000Hz for duration of 75h. The results seem to reveal that the test plants mostly show an increase in biochemical parameters when compared to the control (not exposed to PMF).

Protein

There is an increase in the amount of protein in all the Test samples as compared to the control. In Test 2, the amount of protein increased as 108%, in Test 3 as 88% and in Test 1 as 28% compared to control. The increase in the protein content is supported by the work of. He studied the effects of 0.5 µT WMF (Weak Magnetic Field) produced by Helmholtz rings (with or without light) on neutral lipids and proteins in radish seedlings. Protein content in WMF-treated light-grown plants increased compared with the GMF (Geo-magnetic field) control light-grown seedlings, whereas it remained almost unchanged in dark-grown plants. The increase in protein content may be due to stimulation of amino acid transport driven by ATP.

Table 1: Protein concentration.

S. No.	Sample	Concentration(mg/g)
1	Control	0.92
2	Test 1	1.12
3	Test 2	1.96
4	Test 3	1.88

Carbohydrates

Analysis of the carbohydrates content present in the given barley samples shows that there is only a slight variance in the level of carbohydrates compared to that of the control. It is shown that there is a maximum increase of 16% in Test 3. In Test 2, 8% increase and in Test 1, 4% increase was obtained as compared with the control. In most tissues, starch synthesis takes place largely in plastid. Either Glucose-6-Phosphate (G6P) or Glucose-1-Phosphate (G1P) is imported into plastid as ATP in heterotrophic tissues. Subsequently, G1P and ATP glucose, the substrate for starch synthesis represents the first committed precursor for starch synthesis. Subsequent to this reaction, a complex structure of starch is achieved. It has been found that electrical pulses affect the ATP level and hence produces an increase or decrease in carbohydrate content.[10]

Table 2: Carbohydrate concentration.

S. No.	Sample	Concentration (mg/g)
1	Control	8.40
2	Test 1	8.80
3	Test 2	9.20
4	Test 3	10.00

Nucleic acid content

In the experiments conducted to estimate the Nucleic acid content in *Hordeumvulgare*, it is seen that there is an increase in the amount of DNA in all the test samples as compared to the control. The maximum increase is reached in Test 3 as 168% and Test 1 as 40%, Test 2 as 24% compared to control. This shows that there is an increase in the number of cells implying faster growth of the plants. But, there is a decrease seen in Test samples as compared to the control in the amount of RNA. Test 3 (8%) shows a very small or negligent decrease in the amount of RNA as compared to control. Preliminary studies by Gomathi, 2008 on the total content of DNA in *Cicerarietinum*, was seen to increase in the test values as compared to the control.

Table 3: Nucleic acid concentration.

S. No.	Sample	Concentration(mg/g)
1	Control	4.40
2	Test 1	6.40
3	Test 2	5.60
4	Test 3	12.80

Total amino acid

There is an increase in the free amino acid content in Test 2 and Test 3 as compared to that of the control. The 25% increase in Test 3 and 5% increase in Test 2 were observed as compared to the control It showed that *Viciafaba* seedlings, subjected to a 10 µT 50 Hz square wave magnetic field for 40min together with a radioactive pulse, showed a marked increase in amino acid uptake into intact roots. A more modest increase was observed with a 100 µT 50 Hz square wave. An increase in media conductivity at low field intensities from 10 µT 50 Hz square wave, 100 µT 50 Hz sine wave, and 100 µT 60 Hz square wave fields, indicated an alteration in the movement of ions across the plasma membrane, most likely due to an increase in net outflow of ions from the root cells.[11]

Table 4: Amino acid concentration.

S. No.	Sample	Concentration (mg/g)
1	Control	7.50
2	Test 1	5.50
3	Test 2	8.00
4	Test 3	10.00

CONCLUSIONS

Hordeumvulgare (Barley) seeds were exposed to a Pulsed magnetic field of sine waveform with a constant intensity of 1500 nT and varying frequencies of 100, 500, 1000 Hz. The seeds exposed to the frequency of 100 Hz are taken as Test 1. The seeds exposed to the frequency of 500 Hz are taken as Test 2. The seeds exposed to the frequency of 1000 Hz are taken as Test 3. The seeds are subjected to the Pulsed magnetic field for a time interval of 5 h per day for 15 days. After 15 days, estimations are carried out for Carbohydrate content, Protein content, Amino acids content, Nucleic Acids content (DNA and RNA). It is seen from the results that the magnetic field has enhanced the biochemical parameters of the seeds. From our investigation it was found that an exposure of magnetic field strength of 1500 nT and 1000 Hz frequency for 5 h a day for 15 days has maximum stimulating effect on the biochemical parameters of *Hordeumvulgare* i.e. Test3 (1000 Hz, 1500nT) shows a steady and considerable increase in all biochemical parameters as compared to the Control. Test 1(100 Hz, 1500nT) and Test 2(500 Hz, 1500 nT) also show an increase in some biochemical parameters but it is not as steady as Test 3.

Conflicts of interest

Authors declare no conflict of interest.

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