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Effects of Microwave Radiations on the Morphological and Biochemical Aspects of Some Economically Important Herbs

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Abstract

The purpose of present work was to observe the effects of microwave radiation on some economically important herbs by treating them with microwaved water. Plants studied were *Brassica campestris*, *Lycopersicon esculentum*, *Pedilanthus tithymaloides*, *Portulaca grandiflora*, *Solanum melongena* and *Zinnia elegans*. The results showed that microwave treated water and warm water both inhibited the growth of treated plants as there was significant decrease in the root and shoot length, diameter, fresh and dry weight, reduction in chlorophyll content, leaf area and enzyme activity of peroxidases which was also altered in all the treated plants. It was reported that the microwave radiations were harmful to treated plants and therefore the use of microwave appliances for heating purposes can affect the biochemical nature of food and ultimately can have an affect on human health.

Keywords: Brinjal; Microwave; Morphology; Mustard; Peroxidase; Purslanes.

1. Introduction

Harmful effects of radiations have been reported since long on plants [1,2,3,4,5]. They are known to cause chromosomal aberrations, damage to DNA, inhibition in seed germination and can also damage exposed tissues [6, 2]. Microwaves radiations also have an effect on the enzymatic activities. They are know to affect the enzyme function, cause cell dysfunction and death [7,8]. Peroxidases are involved in many important metabolic processes in plants and are considered to be more regulated under stress conditions, contribute to the defense of plants against pathogens [9]. and to wound healing [10]. They are localized mainly in the cell wall and in vacuoles. Plant roots exude high concentration of peroxidases in soil, particularly in response to water and chemical stress [11].

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Plants peroxidases have been implicated in a number of diverse phenomena observed in plants i.e., lignification, suberization, cell elongation, growth and regulation of cell wall biosynthesis and plasticity. They have been shown to be useful as markers of the reaction of plants to external environmental stresses.

2. Materials and Methods

2.1. Experimental setup /area of work

Three sets of each plant were selected for this work. They were grown in pots in the botanical garden of Kinnaird College, Lahore. One set was treated with tap water and was taken as control, second set was treated with microwave water (1 minute time), and then placed at room temperature for few minutes. It was then applied to one set of all plants. Third set of plants was treated with tap water but heated for few minutes and then cooled at room temperature before applying.

2.2. Water Treatments

Each set was given 300 ml of water of each type. All plants were grown outdoors under natural day light in equal sized earthen pots. Plants selected were of almost same age. They were treated with microwave and warmed water for one month.

2.3. External and Internal Morphology

For external and internal morphology, length and diameter of root and shoot were calculated. Minitab V (13) Mean, standard error of the mean, one way ANOVA were calculated.

2.4. Estimation of Enzymatic Activities (Peroxidases)

In a cold pastle and mortar, weighed and frozen plant material was crushed with phosphate buffer (0.1M; pH 7) (Table 4.1.12) in the ratio of 1:4 (w/v) i.e., 1 gm of plant material; 4 ml of phosphate buffer. The samples were centrifuged at 10,000 rpm for 10 minutes. The supernatant was used for estimation of peroxidases. Two sets of test tubes were labeled (one for experimental and one for control). In all the test tubes (2 sets) 2.5 ml of phosphate buffer (pH 7.0) 0.2 ml of enzyme extract was added. In experimental set 0.2 ml of 1% Guaiacol solution was added and mixed. Both the sets were left at room temperature for 15-20 minutes. Then 0.1 ml of 0.3% H2O2 was added in all the test tubes and stirred. For blank, 0.2 ml of glass distilled water, 2.5 ml of phosphate buffer (pH 7.0) and 0.1 ml of 0.3% H2O2 was mixed. Optical density of all the test tubes was taken against this test tube for blank. The absorbance was taken at 750 nm on a Beckmann 200D spectrophotometer.

Formula used for peroxidases were as follows:

$$\text{Units mg-1} = \frac{\text{O.D of experimental} - \text{O.D. of control}}{\text{O.D of control x mg of fresh plant material}}$$

3. Results

3.1. External Morphology

In the present study, the microwaved water treated plants showed a marked decrease in the growth of the roots, shoots and leaves. The length and diameter of the root and shoot of the microwaved treated plants was highly affected (Table 1-7, fig. 1-6). The number of flower buds was also affected as plants treated with the microwaved water had lesser number of flower buds as compared to the control plants (Table 1-7).

Table 1: Effects of Microwave Radiations on root parameters of treated plants (Readings are the mean of five replicates)

Treated Plants	**length of root (cm)**		
	Treatments		
	Control	**Warm water**	**Microwaved water**
Brassica campestris	4.25±0.033	4.45±0.666	3.89±0.667
Lycopersicon esculentum	6.24±0.122	3.98±0.089	2.88±0.080
Pedylanthus tithymaloides	7.21±0.334	6.55±0.045	4.86±0.031
Portulaca grandiflora	6.88±0.566	4.98±0.001	3.4±0.044
Zinnia Elegans	4.5±0.045	5.09±0.0021	2.29±0.012
Solanum melongena	5.12±0.069	4.64±0.023	4.60±0.012

Table 2: Effects of Microwave Radiations on shoot of *Brassica campestris* (Readings are the mean of five replicates)

Treatments	**Length of shoot (cm)**	**Diameter of shoot (cm)**	**No. of buds**	**Appearance of flowering**
Control	13.3±0.045	0.04±0.067	3	15^{th} day
Warm water	9.05±0.091	1.046±0.012	2	10^{th} day
Microwaved water	9.06±0.002	1.043±0.089	2	12^{th} day

Table 3: Effects of Microwave Radiations on shoot of *Lycopersicon esculentum* (Readings are the mean of five replicates)

Treatments	**Length of shoot (cm)**	**Diameter of shoot (cm)**	**No. of buds**	**Appearance of flowering**
Control	11.4±0.98	1.038±0.67	0	0
Warm water	11.4±0.67	1.033±0.12	0	0
Microwaved water	6.3±0.055	1.034±0.04	0	0

Table 4: Effects of Microwave Radiations on shoot of *Pedylanthus tithymaloides* (Readings are the mean of five replicates)

Treatments	Length of shoot (cm)	Diameter of shoot (cm)	No. of buds	Appearance of flowering
Control	38.4±0.455	1.0885±0.554	0	0
Warm water	35.5±0.002	1.081±0.988	0	0
Microwaved water	33.5±0.129	0.065±0.001	0	0

Table 5: Effects of Microwave Radiations on shoot of *Portulaca grandiflora* (Readings are the mean of five replicates)(Readings are the mean of five replicates)

Treatments	Length of shoot (cm)	Diameter of shoot	No. of buds	Appearance of flowering
Control	19.05±0.778	1.83±0.788	9	10^{th} day
Warm water	20.3±0.233	1.04±0.234	15	15^{th} day
Microwaved water	15.6±0.023	1.032±0.124	17	20^{th} day

Table 6: Effects of Microwave Radiations on shoot of *Solanum melongena* (Readings are the mean of five replicates) (Readings are the mean of five replicates)

Treatments	Length of shoot (cm)	Diameter of shoot (cm)	No. of buds	Appearance of flowering
Control	17.7±0.078	2.95±0.680	0	0
Warm water	13.2±0.124	2.03±0.347	0	0
Microwaved water	11.4±0.045	1.83±0.246	0	0

Table 7: Effects of Microwave Radiations on shoot of *Zinnia elegans* (Readings are the mean of five replicates)

Treatments	Length of shoot (cm)	Diameter of shoot (cm)	No. of buds	Appearance of flowering
Control	25.5±0.687	2.645±0.689	6	14^{th} day
Warm water	20.3±0.123	2.034±0.002	2	16^{th} day
Microwaved water	21.5±0.045	2.032±0.001	2	21^{st} day

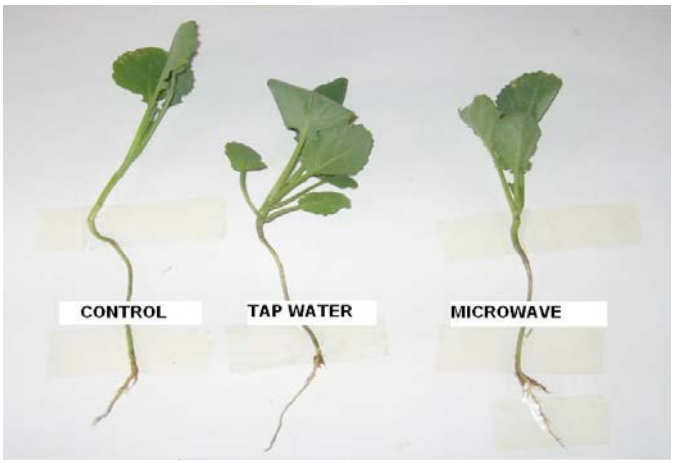

Figure 1: Effects of different treatments on root length of *B. Campestris*

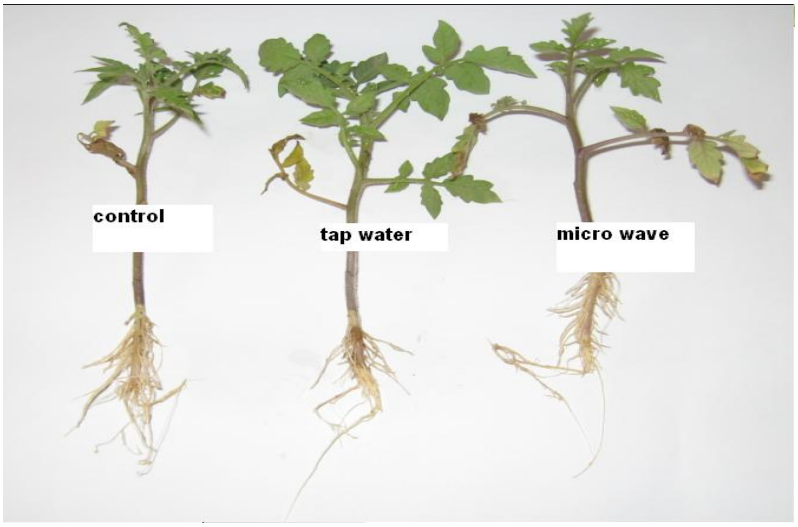

Figure 2: Effects of different treatments on root of *L. esculentum*

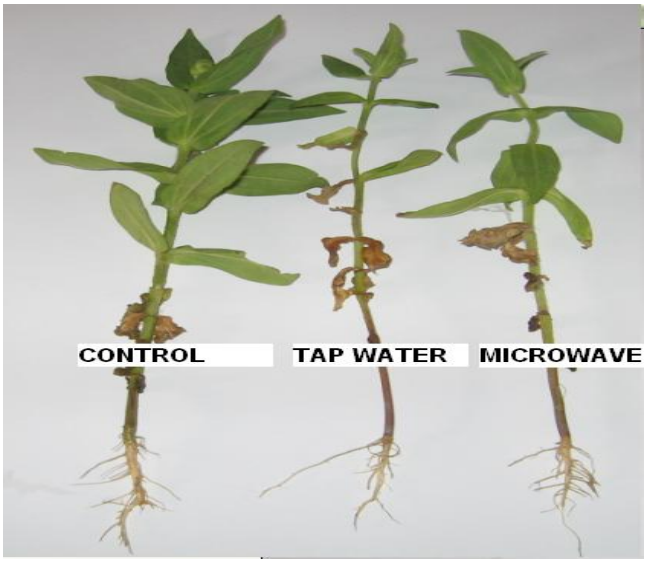

Figure 3: roots of different treatments of Z*innia elegans* in comparison

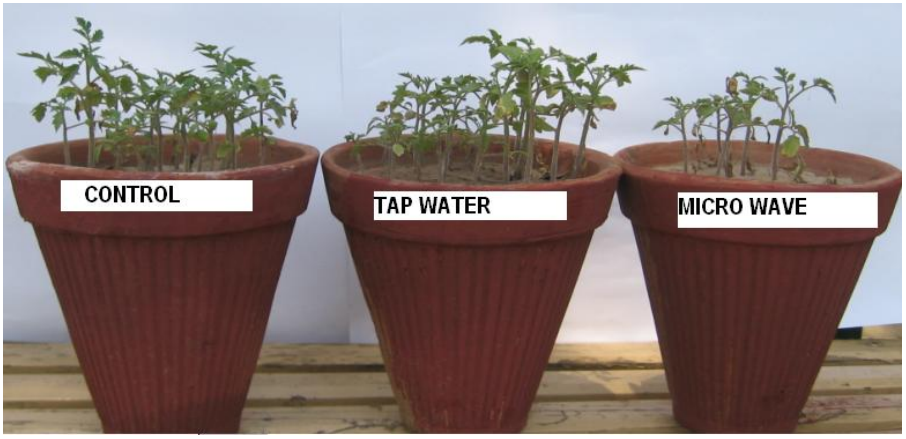

Figure 4: Effects of different treatments on *l. Esculentum*

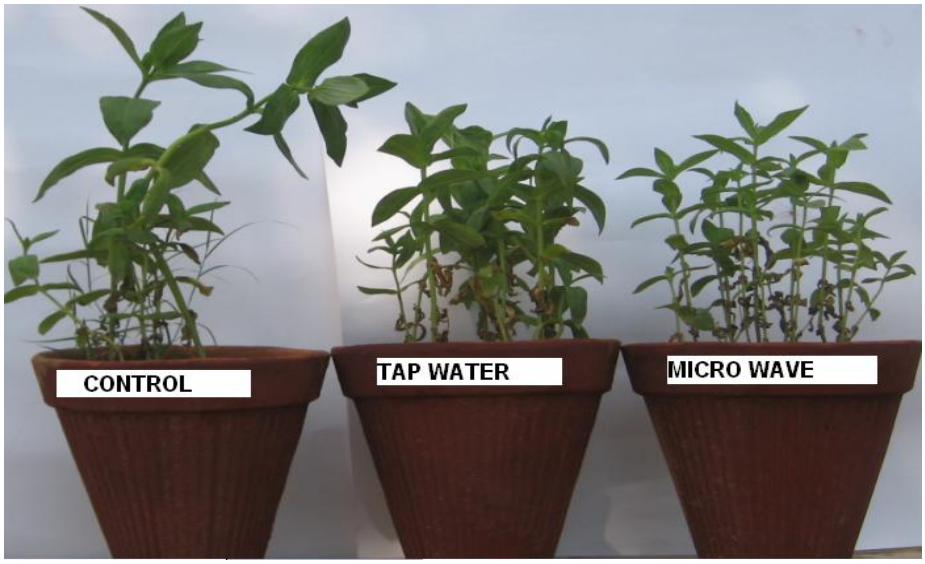

Figure 5: Effects of different treatments on *p. Grandiflora*

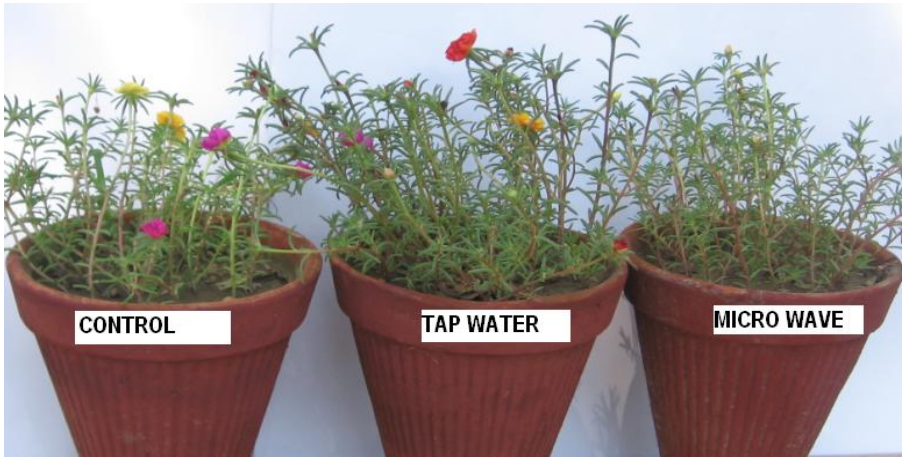

Figure 6: Effects of different treatments on *z. Elegans*

3.2. Internal Morphology

In all the treated plants, significant increase in peroxidase activities was observed in all microwaved treated plants as compared with control. Peroxidase activity was more pronounced in roots of all plants (Table 8-13).

Table 8: Effects of microwaves on the peroxidase activity in *b. Campestris*

Part (mg-1)	**Treatments**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	2.58±0.003	2.05±332.3	3.03±564.31
1st internode (mg-1)	2.18±0.033	2.06±497.9	2.98±25.76
1st leaf (mg-1)	2.09±0.009	1.98±68.07	12.45±89.34 s

Table 9: Effects of microwaves on the peroxidase activity in *l. Esculentum*

Part	**Treatment (ml)**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	4.67±26.09	4.12±37.21	5.67±47.07
1st internode (mg-1)	3.12±55	3.34±106.54	3.87±188.78
1st leaf (mg-1)	1.16±0.95	1.34±1.80	1.87±42.15

Table 10: Effects of microwaves on the peroxidase activity in *p. Tithymaloides*

Part	**Treatment (ml)**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	1.67±34.15	1.12±31.98	2.67±27.19
1st internode (mg-1)	1.12±23.09	1.34±12.98	1.87±89.12
1st leaf (mg-1)	0.16±4.12	0.44±2.19	0.93±56.08

Table 11: Effects of microwaves on the peroxidase activity in *p. Grandiflora*

Part	**Treatment (ml)**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	5.12± 12.08	4.92±12.89	6.12±49.12
1st internode (mg-1)	2.12±6.78	2.46±36.512	2.93±40.78
1st leaf (mg-1)	0.18±8.17	0.81±34.80	0.93±83.12

Table 12: Effects of microwaves on the peroxidase activity in s. *Melongena*

Part	**Treatment (ml)**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	3.75± 12.70	4.32±10.67	4.92± 12.89
1st internode (mg-1)	3.59±4.78	4.46±8.35	4.93±12.98
1st leaf (mg-1)	2.67±9.34	2.81±67.43	1.85±15.78

Table 13: Effects of microwaves on the peroxidase activity in *z. Elegans*

Part	**Treatment (ml)**		
	Control	**Warm water**	**Microwaved water**
Root (mg-1)	5.12± 2.89	6.81±45.11	7.12± 33.71
1st internode (mg-1)	4.12±9.23	4.10±5.89	5.17±63.12
1st leaf (mg-1)	1.75±5.12	1.89±61.2	2.85±10.54

4. Discussion

The treatment of plants with microwaved water resulted in significant inhibition of plant growth as compared with untreated control plants (Table; 1-7, Fig. 1-6). In all the treated plants, many inter and intraspecific differences were observed in response to microwave radiations with respect to growth of root, shoot and leaves. Similar results are reported by many workers [12, 8] with plants under stress. Among the treated plants *L.*

esculentum, B. campestris and *Z. elegans* showed remarkable differences as compared with *P. grandiflora.* Further, flowering in all the microwaved water treated plants was also delayed although bud initiations was observed but yet the flowering was delayed (Table 1-7). Plants under stress caused delay in flowering as flower formation is related to environmental conditions [13,14]. Flower development involves a complex interaction of molecular, biochemical, and structural changes. However, little information is available on the physiology of early flower development, on the molecular aspects of fruit development in general, and on how flower development is coordinated with hormonal action. Plants under stress caused delay in flowering as flower formation as it is related to different environmental conditions [13]. Stress caused inhibition in flowering can be attributed to initiation of disruption in biological processes [8].

In all the treated plants, increase in enzyme activity was observed (Table 8-13), further indicating the role of radiations in inducing stress in different parts of plants. The role of peroxidase as a stress enzyme in plants has been widely accepted [15]. Maximum enzyme activity was detected in roots, then in shoot and in leaves. This might be due to different level of stress of tolerance different plants [16]. Roots of plants were more responsive to stress because peroxidase activity was maximum in the roots of treated plants, showing the sensitivity of roots to microwaved radiations.

5. Conclusions

The harmful effects of microwave radiation was reported in all the treated plants.The results were correlated to the facts that radiations can also cause damage to human tissues. Different plants were treated in order to observe the effects of microwave radiations. Changes caused by radiation were reported to be inhibitory for all the treated plants showing that harmful radiations can also interact with the enzymes causing a disruption of biological processes in plants.

6. Recommendations

This research work reports that effects of microwaved radiations cause inhibitory effects on the growth of all treated plants so it is suggested that microwaved radiations are not good for human health and use of microwave in everyday life should be minimized as microwaved radiations change the nature of food and cause abrupt biological changes.

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