

To Study the Influence of Microwave Oven Treated Water on Germination and Growth of *Trigonella foenum-graecum*

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ABSTRACT

Microwave oven has become the most favorite means of cooking and reheating device in the modern era. It reduces the heating time to a considerable amount. Having electromagnetic waves, the domestic microwaves may affect the growth of the plants. So the current paper has been planned to investigate the influence of microwave oven treated water on the germination and growth of *Trigonella foenum-graecum*. For this purpose household microwave oven was used. Water was irradiated for 10s, 20s, 40s, 80s and 120s in microwave and then supplied to the test plant. Percentage of germination and other growth parameters have been recorded. It is concluded from the present study that water exposed to microwave oven for the shorter duration (10s, 20s, 40s) showed an enhancing effect, while longer exposure treatment (80s and 120s) had a depressive effect on all the growth parameters. The stimulatory effect of microwave is agronomically important and can be used for the crop improvement in the near future. As homemade food items should be safe for

consumption, so author warns the general public about the prolonged use of microwave ovens.

Keywords Household microwave oven, *Trigonella foenum-graecum*, Germination, Growth parameters.

INTRODUCTION

Day by day new and emerging technology is evolving and it has a significant effect on human life. In the fast modern life a number of inventions have entered into our homes and have considerably changed the way of working of people. Our kitchen is likewise not away from it. Modern kitchens are also equipped with a number of latest cooking appliances. In the list of modern kitchen appliances the microwave oven has occupied the top position as the sense of popularity. In 1967 first household microwave oven was introduced and by 1980 it has become a necessary item of every kitchen. It has become the first choice of every one, because of its immense beneficial roles like-it saves cooking time, convenient to use, easy to clean and there is no need to keep eyes on cooking all the time. According to Sloan (2013), microwaving is the 3rd most popular domestic heating method after baking and grilling for cooking and heating foods. Microwave ovens play an important role in cooking not-ready-to-eat (NRTE) foods as well heating the ready to eat (RTE) food items.

Microwaves are high frequency radio waves and are the part of the electromagnetic spectrum.

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Microwave oven work by discharging microwave radiations, the frequencies of which are only somewhat shorter than the radio waves utilized in radars. Microwave energy penetrates deeper in the solid or liquid food materials and utilized this energy to vibrate the water particles of food many times per second by producing lots of heat rapidly and thus reduce the overall cooking time many folds. Microwaved treated water has higher pH, conductivity and high water molecule mobility (Wong *et al.* 2009). The conductivity of microwaved water was higher due to reduced clustering propensity in bulk phase (Jaffere *et al.* 2017a, Seifi 2016). In spite of a number of positive effects microwave ovens also have some negative effects which are reported by many scientists. In a study (Benedict *et al.* 2017) consumption of microwaved foods resulted in a significant decrease in antioxidant protection. The effect of microwave radiations on seed germination, plant growth and development was studied by many scientists (Ragha *et al.* 2011, Radzevičius *et al.* 2013, Abu-Elsaoud 2015). When the rats has been exposed to microwave radiation at frequencies of 0, 900, 1800 and 2450 MHz (SARs: 0, 0.59, 0.58 and 0.66 mW/kg, respectively) using a transverse electromagnetic cell for 2 months for 2 h/d, 5 d/week and a significant DNA damage has been reported (Megha *et al.* 2015). Some research suggests every microwave has a radioactive source which has carcinogenic effect (IARC 2011).

Since the experiments on humans with microwaves are impossible, on the other side plants do not require any unique facility and do not have statutory obligations, so would be the best option to assess the effect of microwaves.

Thus the present study has been planned to measure the germination percentage and growth parameters of *Trigonella foenum-graecum*, when treated with microwave irradiated water. Fenugreek (*Trigonella foenum-graecum* L.) is a tender, annual herb and used as spice crop throughout the world. It is a popular leafy vegetable. *Trigonella* belongs to family Fabaceae. It is an herbaceous plant with height of 40–80 cm. It has an erect, smooth, hollow hairy stem with branches arise at its base. The leaves are small, alternate with three ovate green leaflets. The

Table 1. Water samples and exposure time in microwave oven.

Irradiated water samples	Exposure time in microwave oven
S ₁	10s
S ₂	20s
S ₃	40s
S ₄	80s
S ₅	120s
Control	Normal drinking water

flowers are white, yellow or purplish blue in color and papilionaceous in structure (Ecocrop 2017). The fruits are in form of pod (2–10 cm long) with pointed tip and contains seeds which are oblong or square, green-olive or brownish in color. Due to pungent odour its seeds are used as spices (Ecocrop 2017). Its vegetative parts are highly valuable as fresh leaves are used as vegetable in many parts of the world. *Trigonella* also has a number of medicinal-properties like it is antidiabetic, anticarcinogenic, hypocholer terolemic, antioxidant and has immunological activities. *T. foenum-graecum* might act as strong natural antibiotic and antioxidant agent and can be used against many inflammatory diseases (Ahmad *et al.* 2018).

MATERIALS AND METHODS

The main purpose of the current experiment was to examine the effect of microwave oven treated water on the vegetative growth of the test plant. For investigation the water was exposed to domestic microwave radiations with power level of 1000 watt, for the duration of 10s, 20s, 40s, 80s, 120s. Germination percentage was calculated and the growth of the fenugreek seedlings were studied for 30 days to analyze the effect of microwave oven irradiated water on the vegetative growth of the plants.

The seeds of fenugreek were soaked in microwave oven irradiated drinking water viz-S₁, S₂, S₃, S₄ and S₅ (Table 1) for 6 h, while controlled seeds were soaked in normal drinking water only. Seeds were sowed in separate pots containing 4 kg of clay loam soil. For each sample experiment was set in

Table 2. The effect of microwave oven irradiated water on the germination and the growth parameters of *Trigonalla foenum-graecum*.

Water samples	Ger %	Mean no. of leaves	Mean PH (cm)	Mean RL (cm)	Mean SL (cm)	Mean RF wt (g)	Mean SF wt (g)	Mean RD wt (g)	Mean SD wt (g)
S ₁	70	8.5	26.59	2.49	31.85	1.652	4.766	0.082	1.175
S ₂	76.7	9.4	35.82	2.53	37.69	1.698	4.896	0.119	1.226
S ₃	80	10.7	44.72	2.77	46.55	1.783	4.969	0.125	1.333
S ₄	66.7	11.1	46.45	2.88	48.05	1.968	4.998	0.143	1.385
S ₅	53.3	7.2	20.13	2.17	22.49	1.214	4.183	0.045	1.049
Control	63.3	8	22.18	2.19	23.44	1.506	4.710	0.064	1.070

three replicates. 10 seeds in each pot were sown. 100 ml of water exposed to different durations in microwave oven (S₁, S₂, S₃, S₄ and S₅) was supplied to each pot. Watering the pots was repeated with S₁, S₂, S₃, S₄ and S₅ water samples in a day after day pattern. One experiment was kept as control and supplied with normal non irradiated drinking water in same way. All the pots were kept in green house. Then seeds were allowed to germinate and recorded after 5 days of sowing the seeds. Germination percentage was calculated by following formula :

$$\text{Germination percentage (GP \%)} = \frac{\text{Number of emerged seedlings}}{\text{Total number of seeds}} \times 100$$

After emergence of first leaf, the treatment of soil with irradiated water samples (S₁, S₂, S₃, S₄, S₅) was continued for 25 days in a day after day manner. The control was allowed to grow with normal water only. 10 seedlings per sample were randomly collected after 30 days and examined for various growth parameters like number of leaves grown per plant, plant height (cm), root and shoot length (cm), root and shoot fresh weight (cm) and root and shoot dry weight (cm). For all the parameters mean value was calculated.

By counting the number of leaves per plant, the number of leaves grown per plant were calculated. Plant height was measured from soil surface to tip of the tallest branch. After 30 days the plants were harvested to measure shoot and root lengths. The root length was measured from the point where the

root and shoot joins to the end of root, while the length up to the apex of shoot considered to be as shoot length. The shoot was separate out from root at the point where they are attached together. The separated root and shoot samples were kept in an oven at 70°C. Digital balance was used to record the fresh and dry weight of root and shoot separately.

RESULTS AND DISCUSSION

The effect of microwave oven treated water on the germination and the growth of *Trigonella* was depicted in Table 2. It's clear from the Table 2 that the water irradiated in microwave oven for the shorter durations (10s, 20s, 40s) increased the rate of germination in a duration dependent manner. According to (Radzevičius *et al.* 2013) the electromagnetic waves of microwave at a certain power can effectively activate various enzymes involved in seed germination and so improve the germination rate (GR).

The water irradiated for longer duration of 80s and 120s decreased the rate of germination and reduction is amplified with the increase in the exposure time. When the *Trigonella* was treated with water irradiated for 120s, the germination percentage value was declined below the control value.

A number of growth parameters were also studied in the current study and results are shown in Table 2. These parameters are the general sign for the growth rate of plants under a particular environmental conditions and have been studied by many scientists in various experimental plants (Alattar

et al. 2017, Jaffer *et al.* 2017b, Jakubowski *et al.* 2010). Table 2 clearly indicated that water samples irradiated for shorter duration (S_1 , S_2 , S_3) showed a stimulatory effect on all the growth parameters as compared to control. The results of current study are similar to the study of (Radzevičius *et al.* 2013), who also reported a stimulation effect on germination and growth rate parameters by microwave irradiation in some vegetable seeds. Jaffer *et al.* (2017a, b) also found similar results in chick pea, chavli and masor seeds and concluded that exposure to microwaved water for a specific time duration showed a better growth rate as compared to normal water. Positive growth rate in lentil seeds was reported for exposure time of 30s (Aladjadjiyan 2010). Microwave pre-treatment supports the expression of the genes which encodes peroxidase (POD) and superoxide dismutase (SOD) isozymes (Aladjadjiyan 2012) and so increase the germination potential, GR, stem length, root length (Radzevičius *et al.* 2013).

In the current study water samples irradiated for longer duration (S_4 , S_5) showed a decreasing effect with decreasing trend on all the growth parameters. Same trend of growth traits were reported by Abu-Elsaoud and Qari (2017) in *Hordeum vulgare*. Gupta *et al.* (2013) reported that exposure time up to 60s helped in the growth of plants in mustard, but the longer exposure durations (more than 60s) inhibited the growth of seedlings. In the present study it has been observed that the exposure time up to 80s showed an enhancing effect on the plant vigor, which decreased drastically when treated the plants with water irradiated for 120s. In contrast according to a study done by Jaffer *et al.* (2017a, b) exposure time of around 180s helped in the growth of the chick pea plants. The results of the present study are found to be in agreement with the study of Abu-Elsaoud (2015), where one or more low doses of microwave radiations showed a possible stimulation effect on growth and germination of six different Egyptian genotypes, but the effect was significantly decreased by higher exposure doses. On contrary the analysis of corn seedlings which were exposed to microwaved water showed lower growth rate in comparison to the control ones (Radha *et al.* 2016, Alattar *et al.* 2018).

CONCLUSION

It is clear from the above result and discussion that microwave irradiated water for short period showed a positive effect on germination and other growth parameters, while when irradiated for longer period showed the negative consequences. So the author suggested to restrict the use of microwave oven for long durations as much as possible.

REFERENCES

- Abu-Elsaoud AM (2015) Effect microwave electromagnetic radio frequency on germination and seedling growth consequences of six wheat *Triticum aestivum* cultivar. *Adv Environm Biol* 9 (24) : 270—281.
- Abu-Elsaoud AM, Qari SH (2017) Influence of microwave irradiations on germination, seedling growth and electrolyte leakage of Barley (*Hordeum vulgare* L.). *Catrina* 16 (1) : 11—24.
- Ahmad A, Verma HN, Dev K (2018) Indian medicinal plant *Trigonella foenum-graecum* : Phytochemicals detection and pharmacological studies. *Asian J Pharmac Clinical Res* 11(8) : 230—236. DOI:<http://dx.doi.org/10.22159/ajpcr.2018.v11i8.21200>.
- Aladjadjiyan A (2010) Effect of microwave irradiation on seeds of lentils (*Lens culinaris*, Med). *Rom J Biophys* 20 (3) : 213—221.
- Aladjadjiyan A (2012) Physical factors for plant growth stimulation improve food quality. *Food Production – Approaches, Challenges and Tasks*, pp 145—168.
- Alattar E, Elwasife K, Radwan E, Elrif Y (2017) Response of corn (*Zea mays*), basil (*Ocimum basilicum*) and eggplant (*Solanum melongena*) seedlings to WI-FI radiation, of corn (*Zea mays*) and pepper (*Capsicum annum*) seedlings. *Rom J Biophys* 27 : 137—150.
- Alattar EM, Elwasife KY, Radwan ES, Alagha AM (2018) Effect of microwave treated water on the growth. *Biophys* 28 (3) : 115—124.
- Benedict CE, Jibiri NN, Bede EN, Bede CA, Chikwendu I (2017) Effect of ingestion of microwaved foods on serum anti-oxidant enzymes and vitamins of albino rats. *J Radiation Res Appl Sci* 10 : 148—151.
- Ecocrop (2017) Ecocrop database. FAO, Rome, Italy, <http://ecocrop.fao.org/ecocrop/srv/en/home>
- Gupta A, Singh R, Lehana P (2013) Effect of microwave treated soil on growth of mustard plants. *Int J Engg Adv Technol (JEAT)* 2 : 808—812.
- IARC (2011) WHO : IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans. http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf.
- Jaffer F, Firfire R, Patil M (2017) Effect of microwave treated water on germination of *Vigna unguiculata* (cowpea) seeds. *Scholarly Res J Humanity Sci English Language* 4 : 4738—4744.

- Jaffer F, Pingale M, Sapale P, Padval S (2017) Effect of microwave treated water on germination of chickpea seeds. *Scholarly Res J Humanity Sci English Language* 4 : 4956—4960.
- Jakubowski T (2010) The impact of microwave radiation at different frequencies on weight of seed potato germs and crop of potato tubers. *Agric Engg* 6 : 57—64.
- Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R, Abegaonkar MP(2015) Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. *Neurotoxicology* 51 : 158–165. doi: 10.1016/j.neuro.2015.10.009.
- Radha K, Mrudula Rao BV, Sujatha M, Sirisha D (2016) Impact of microwave heated water on germination of seeds and growth of plant systems. *World J Pharmac Res* 5 (6) : 1786—1797.
- Radzevičius A, Sakalauskienė S, Dagys M, Simniškis R, Karklelienė R, Bobinas C, Duchovskis P (2013) The effect of strong microwave electric field radiation on vegetable seed germination and seedling growth rate. *Zemdirbyste-Agriculture* 100 (2) : 179—184.
- Ragha L, Mishra S, Ramachandran V, Bhatia MS (2011) Effects of low-power microwave fields on seed germination and growth rate. *J Electromag Anal Appl* 3 (5) : 165—171.
- Sloan E (2013) Demographic redirection. *Food Technol July*, pp 38—50.
- Seifi K, Torshizi M, KazemifardM (2016) Effects of microwave-treated drinking water on growth and some physiological characteristics of Japanese quail (*Coturnix coturnix japonica*). *Iran J Appl Anim Sci* 6 : 447—451.
- Wong TW, Iskhandar A, Kamal M, Jumi S, Kamarudin N, Mohamad Zin N, Mohd Salleh N (2009) Effects of microwave on water and its influence on drug dissolution. *Prog Electromag Res* 11 : 121—136.