The Effect of Magnetic Treated Water and Foliar Nanofertilizer on the Active Ingredient of Fenugreek (Trigonellafoenum-graecum)

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Abstract

Afak district center of Al-Diwaniyah Governorate was chosen as a site for carrying out the study during the growing season 2018-2019 corresponding to 11/15/2018 using the method of cultivating potatoes for fenugreek seeds with the aim of determining the effect of magnetic treated irrigation water with differenttensiones (0, 750, 1500, and 3000) guass and spraying concentrations of foliarnanofertilizer(0) and recommended (1) and twice the recom mended (2)) g. L-1. In the indicators of the active substance of fenugreek plant, fenugreek seeds were sown in pots, at the rate of 10 seeds per pot, on 15/11/2018. After five days had passed, the germination was obtained at 100% for all the seeds sowing, and then watering operations for fenugreek plants with magnetic treated water were applied according to the strengths to be tested hidden Forced to treat irrigation water one month after the date of planting. Fenugreek plants were also sprayed with different concentrations of foliar nanofertilizer for the first time on 25/12/2018 and the second time on 15/1/2019. The indicators studied on fenugreek plant included indicators of ratios of the chemical component of fenugreek seeds [Trigonelline (%),Choline (%), Rhaponticin, Diosgenin (%) and Fenugreekine (%)]The results showed the significant effect of treated water on recording the highest averages of the studied plant indicators compared to the indicators caused by magnetic untreated water (comparison) as well as the significant moral superiority of magnetic treated water of 750 guass in recording the highest averages for the ratio of active ingredient Choline (%), Rhaponticin (%), and Trigonelline (%)with magnetic treated water at 1500 guass, as well as Diosgenin (%) and Fenugreekine (%) which significantly outperformed with treated water strongly 3000 gauss.

Key Words: Fenugreek, Magnetic Treated Water, Nanofertilizer.

DOI Number: 10.14704/nq.2020.18.9.NQ20217 **NeuroQuantology 2020; 18(9):64-70**

Introduction

Fenugreek is a popular spice in human food, and green fenugreek seeds and leaves are used in food as well as in medical applications that are ancient practices of human history, as its seeds were used to increase flavor and color as well as in adjusting the strength of foodstuffs, and fenugreek seeds have medicinal properties such as lowering blood cholesterol (Hypocholesterolemic),

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 17 July 2020 **Accepted:** 18 August 2020

Antibacterial, Gastric stimulant on Anorexia, Antidiabetic agent, Galactogogue, Hepatoprotective effect and Anticancer, these beneficial physiological effects including agitation Diabetes and lower cholesterol levels in the arena are mainly attributable to the components of the Inner Nutritional Fibers with a promising nutritional value (Srinivasan, 2006).

It is known for its Fibers, Gums fibers and other chemical components and volatile contents, and the fibrous fiber of fenugreek seeds is about 25% of what changes the food structure, as it is used as a food stabilizer, Adhesive and Emulsifying because of its high content of fibers, protein and glues, in addition to Fenugreek protein is more soluble in alkaline pH (Meghwal and Goswami, 2012).

Fenugreek has a beneficial effect on blood cleaning, and as a sterile Diaphoretic, it is able to stimulate the body to produce sweat and help remove toxins from the body, and because of its pungent smell that smells of skin and sweat under the arm, it is also known for its activity in lymphatic cleansing despite its vital role of Irrigate cells with nutrients and remove toxic waste, dead cells and retained proteins from the body (Baba *et al*., 2018).

Magnetic water treatment technology uses magnetron devices that generate a strong magnetic field around water through the wall of irrigation water pipes, which changes the physical and chemical properties of the water through it (Hozayn and Abdul-Qados, 2010). Qados and Hozayn (2010) indicated that exposing water to magnetic fields leads to reducing the size of water molecules and thus works to increase their solubility by reducing viscosity and surface tension, thus reducing their surface area, which makes it easier to cross (water molecules) and the nutrients it carries through the cell membrane. The magnetic field also affects the angle of hydrogen bonding in the water molecule, as it decreases from 104º to 103º, which leads to the formation of cluster groups consisting of 6-7 molecules compared to the natural state in which the groups consist of 10-12 molecules, and this leads to the ease of entering and absorbing water. By root hairs (Toledo *et al*., 2008). Ahmed (2009) showed that the molecular shape of water and how the oxygen atom relates to the two hydrogen atoms and the amount of angle between them changes when passing it in a magnetic field with a specific overflow density so that the water molecules go in one direction after they were scattered. Banejad and Abdosalehi (2009) stated that irrigating the soil with magnetized water reduced its electrical conductivity by 4.46 dCi. M-1 compared to soil irrigated with non-magnetized water of 6.31 dCi. M-1 as well as the role of magnetic water in reducing the amount of salts in the soil. Magnetization of irrigation water helps break down the hydrogen bonds in salt water, which helps to wash the soil and facilitates the absorption of water and minerals by the plant, increases its ability to resist diseases and reduce its consumption of chemical fertilizers (Toledo et al., 2008). Tai *et al.* (2008) showed that magnetized water prevents the absorption of plant roots of toxic elements such as lead and nickel, and in turn increases the absorption of nutrients such as phosphorus, potassium and zinc. In addition to its role (magnetic treatment) in reducing water hardness by 51% (Banejad and Abdosalehi, 2009).

Nanotechnology focused on the special properties of nanoscale materials has the potential to revolutionize food, biomedicine, environmental engineering, safety, security, water resources and energy transformation, as well as many other areas (Baruah *et al*., 2008). Nanotechnology applications in agriculture are gradually transforming theoretical potentials into practical applications, as new tools are designed that can operate at nanoscale levels to support research in molecular and cellular biology, and nanotechnology has the potential to increase agricultural productivity through genetic improvement of plants and animals (Kuzma *et al.*, 2006; Scott, 2007) along with cellular delivery of genes and drug molecules to specific sites in plants and animals (Maysinger, 2007). This potential increases with the effectiveness of nanotechnology with the identification of technologies and sensors suitable for precision agriculture, natural resource management, early detection of pathogens and pollutants in food products, effective delivery systems for agricultural chemicals such as fertilizers and pesticides, and improved systems integration for food processing, packaging and other areas Such as monitoring the security of the agricultural and food system (Moraru *et al.*, 2003; Chau *et al*., 2007; Subramanian and Rahale, 2009; Subramanian *et al.,* 2015). With the increase in innovations that use nanotechnology in the agricultural sector, it is conceivable that it will become the main economic driving force and benefit consumers and farmers without any adverse impact on the ecosystem (Preetha and Balakrishnan, 2017).

The Aim of the study Knowing the effect of the strengths of the magnetic field treated for irrigation water and the effect of spraying with different concentrations of integrated foliar nanofertilizer and its effect on the proportions of the active compounds for fenugreek plant, and determining the optimum intensity and optimal concentration of each factor as well as the combination resulting from their overlapping in giving the highest indicators of the active substance of the fenugreek plant.

Materials and Methods Work

Fenugreek plants were treated with the magnetic treated water after a month of cultivation and with different concentrations of foliarnanofertilizer previously prepared for the first time on 25/12/2018 and for the second time on 15/1/2019 by spraying the vegetative method with a 1-liter manual sprinkler early in the morning with irrigation Advance plants to avoid closing stomata due to dehydration as well as increasing the absorption efficiency of the sprayed material (Gruda, 2005), taking into account all precautions and measures necessary to prevent interaction of the spray process between one treatment and another. In addition, the art of service operations for plants and monitoring of pots in anticipation of a fungal or insect infection was carried out continuously until the measurements under study were taken on day5/2/2019 As for the date of the end of the experiment was on 10/3/2019, which like the date of harvest plants and taking the winning measurements.

Detection of the Chemical Component of Fenugreek Seeds by GC-MS Technology

The extraction process was carried out according to the method of (Muhit *et al*., 2010) with some modification. 1 g of dry seed meal was extracted by 10 ml of methanol (99%) with stirring for 5 minutes, then left for 6 hours in a dark place at room temperature and then filtered By means of a microscopic filter (0.45 micrometer) connected to a medical syringe, then its chemical components will be revealed, as this test was conducted in the laboratories of the Water and Soil Research Unit of the Ministry of Science and Technology for the purpose of diagnosing and estimating effective compounds by a GC-MS device (type Shimadzu GC-MS 2010) Japanese-origin equipped with the system GC clarus 500 Perkin Elmer, which includes the unit identification Auto sampler [AOC-10i + s] for vehicles, gas chromatography bound to mass spectrometry, and according to the conditions of the method the active compounds were determined [1] based on the interpretation of the mass spectrum of GC-MS, and after obtaining the mass spectrum of each compound the results were processed through a program GC-MS solutions and definition of Peaks curves separated based on the National Institute Standard and Technology database (NIST) containing more than 62,000 known patterns, and compare the resultant spectrum of the unknown component with a range of known compounds in the library the device is equipped with to ensure that Name, molecular weight, and The intention of the components of the test materials.

Results and Discussion

The effect of magnetic treated water and foliar nano fertilizerand their interaction on percentage of the chemical component of T. Fenum-graecum seeds by GC-MS technology.

1. The Percentag of Active Ingredient Trigonelline (%)

From the results of the statistical analysis of the data presented in Table (1), the significance of magnetically treated water and foliar nanofertilizer and their interference in the mean percentage of active substance Trigonelline in the fenugreek seeds was observed, as magnetic water treatment with strength of 1500 guass was recorded, the highest average of active substance percentagwas 47.26%. An increase of 17.80% over comparison plants with an average of 40.12%.

It was also noticed that spraying foliar nanofertilizer on the vegetative group of fenugreek plants significantly increased the percentage of active ingredient Trigonelline from 41.61% for comparison plants to 44.26 and 45.00% for plants treated with concentrations 1 and 2 g. L^{-1}, respectively, with an increase over the comparison plants of 6.37 and 8.15%, respectively.

The two-way interaction between the magnetized water and the foliar nanofertilizer gave a significant difference to percentagof the active substance Trigonelline, as the treatment of magnetized treated water at the intensity of 1500 guass was recorded with the paper nanofertlizerat a concentration of 2 g. L^{-1} was the highest significant

mean for the active ingredient percentage, Trigonelline, reaching 50.18%, with an increase of 23.66% over comparison plants with an average of 40.58%.

Table 1. Effect of Magnetic Treated Water and Foliar Manure and their Interference Average Trigonelline Effective percentag in Seeds of T. Fenum-graecum (%)

Magnetic treated water (guass)	foliar nanofertilizer (g.L^{-1})			Average effect of magnetic treated water
	0	1	2	
0	40.58	40.23	39.56	40.12
750	41.16	43.71	44.57	43.15
1500	43.37	48.22	50.18	47.26
3000	41.31	44.87	45.68	43.95
Average effect of foliar nanofertilizer	41.61	44.26	45.00	
LSD (P ≤ 0.05)	Waterproof processor 0.1288 =	For nanofertilizer = 0.1115	To Interaction = 0.2231	

Table 2. Effect of Magnetic Treated Water and Foliar Nanofertilizer and Their Interference Average Choline (%) Effective ingredient percentag in Seeds of T Fenum-graecum.

Magnetic treated water (guass)	foliar nanofertilizer (g.L^{-1})			Average effect of magnetic treated water
	0	1	2	
0	22.79	24.48	31.51	26.26
750	29.39	35.05	35.16	33.20
1500	26.62	34.32	34.92	31.95
3000	23.82	31.07	34.17	29.69
Average effect of foliar nanofertilizer	25.66	31.23	33.94	
LSD (P ≤ 0.05)	Waterproof processor = 0.1855	For nanofertilizer =0.1606	To Interaction = 0.3213	

2. *The percentag of active ingredient Choline %*

The results of Table (2) showed that the average percentage of choline for fenugreek seeds was of significant differences due to the effect of different magnetic treatments of water, as the highest average percentage of active substance Choline 33.20% in plants irrigated with magnetic treated water with a force of 750 guass compared to the average ratio of material effective Choline for comparison plants, which reached 26.26% and an increase of 26.43%.

Fertilizers gave the foliar nanofertilizera significant increase in the average percentage of active ingredient Choline for fenugreek seeds with an increase in the concentration used, as it reached 33.94% at the concentration of 2 g. L^{-1} for foliar nano fertilizer with an increase of 32.27% over comparable plants with an average of 25.66%.

As for the interaction between the two study factors, its effect was significant on the percentag of root length, as it reached the highest average percentage of active substance Choline 35.16% when irrigating plants with magnetic treated water with 750 guass and sprayed with 2 g. 1 liter of foliar nano fertilizer with an increase of 54.28% compared to untreated plants that recorded 22.79%.

3. *The Percentag of Active Ingredient Rhaponticin (%)*

The results of Table (3) gave significant differences for magnetically treated water and foliar nanofertilizer and their interaction in the average percentag active ingredient Rhaponticin in fenugreek percentag reached 28.20% and an increase of 13.85% over Comparative plants with an average of 24.77%.

It was also observed that spraying foliar nanofertilizeron the vegetative group of fenugreek plants significantly increased the percentag of the active ingredient Rhaponticin to the highest 32.04% in the seeds of plants treated with a concentration of 2 g. L^{-1}, with an increase of 49.51% on comparison plants, with an average of 21.43%.

Interaction between the magnetic treated water and the foliar nano fertilizer gave a significant superiority to the percentag of the active ingredient Rhaponticin, as the treatment of magnetic treated water at the intensity of 750 guass was recorded with the foliar nano fertilizer at a concentration of 2 g. L^{-1} was the The highest mean average for the active ingredient Rhaponticin rate of 33.15%, with an increase of 58.16% over comparison plants with an average of 20.96%.

Table 3. Effect of Magnetic Treated Water and Foliar Nano fertilizerand Their Interference Average Ratio of Effective Rhaponticin (%) in Seeds of T. Fenum-Graecum

Magnetic treated water (guass)	foliar nano fertilizer (g.L^{-1})			Average effect of magnetic treated water
	0	1	2	
0	20.96	21.71	31.64	24.77
750	22.42	29.04	33.15	28.20
1500	21.51	27.82	32.09	27.14
3000	20.84	24.28	31.27	25.46
Average effect of foliar nanofertilizer	21.43	25.71	32.04	
LSD (P ≤ 0.05)	Waterproof processor =0.1873	For nanofertilizer= 0.1622	To Interaction= 0.3244	

Table 4. The effect of magnetic treated water and foliar manure between them and their average mean percentage of active substance Choline (%) in seeds for T. fenum-graecum

Magnetic treated water (guass)	foliar nanofertilizer (g.L^{-1})			Average effect of magnetic treated water
	0	1	2	
0	20.96	21.71	31.64	24.77
750	22.42	29.04	33.15	28.20
1500	21.51	27.82	32.09	27.14
3000	20.84	24.28	31.27	25.46
Average effect of foliar nanofertilizer	21.43	25.71	32.04	
LSD (P ≤ 0.05)	Waterproof processor= 0.1873	For nanofertilizer= 0.1622	To Interaction = 0.3244	

4. The Percentag of the Active Ingredient Diosgenin %

It was noted from the results of Table (4) irrigation water with the highest intensity of the used magnetic field under study 3000 guass compared to untreated plants which the average percentage of the active ingredient Diosgenin in its seeds was 14.34% and an increase of 32.22%.

As for the effect of foliar nano fertilizer, its addition led to a significant increase in the average percentage of active ingredient Diosgenin in fenugreek seeds on the seeds of comparison plants, as it reached 25.22 and 48.58% when treatment with 1 and 2 g. L^{-1}, which recorded 16.73 and 19.85%, respectively, compared to 13.36% for the comparison plants.

Moral interference between the magnetic treated water gave the severity of 3000 guass and the foliar nano fertilizer at a concentration of 2 g. L^{-1} was the highest significant average of the active ingredient percentage Diosgenin in fenugreek seeds reached 23.12% compared to 11.31% for comparison plants and with an increase rate that exceeded 100%, reaching 104.42%.

5. The Percentag of the Active Ingredient Fenugreekine (%)

The results of Table (5) showed that the treatment of irrigation water magnetic with the highest intensity used under study 3000 guass increased significantly from the average percentage of the active ingredient Fenugreekine in fenugreek seeds to above, as it reached 7.74% compared to the average of the same trait in comparison plants, which reached 6.07 % With an increase of 27.51%.

With regard to the addition of Foliar nanofertilizer, they returned with a significant moral result in increasing the average percentage of active substance Fenugreekine in fenugreek seeds on the seeds of comparison plants with increasing the concentration used, as it reached 7.43% when treatment with the highest concentration used under study 2 g. Liter^{-1} for foliar manure compared to 6.21% for comparison plants and with an increase of 22.41%.

As for the moral overlap between the two study factors, the intensity of 3000 guass of magnetic treated water was achieved with a concentration of 2 g. L^{-1} of Foliar nanofertilizer is the highest mean for Fenugreekine active ingredient in fenugreek seeds, as it reached 8.75% compared to 5.49% for comparison plants and an increase of 40.90%.

Table 5. Effect of Magnetic Treated Water and Foliar Nanofertilizer and Their Interference Average Fenugreekine(%) Effective percentage in Seeds of T. Fenum-graecum

Magnetic treated water (guass)	foliar nanofertilizer (g.L^{-1})			Average effect of magnetic treated water
	0	1	2	
0	5.49	6.20	6.52	6.07
750	5.84	6.88	7.18	6.63
1500	6.99	7.14	7.25	7.13
3000	6.52	7.94	8.75	7.74
Average effect of foliar nanofertilizer	6.21	7.04	7.43	
LSD (P ≤ 0.05)	Waterproof processor = 0.0305	For nanofertilizer = 0.0264	To Interaction =0.0529	

The increase in the active ingredient or chemical components of the seeds produced by plants irrigated with magnetized water with different stresses under study is due to the stimulating effect of irrigation with magnetic treated water on the growth indicators causing induction of mitosis and cell metabolism, and all the catalytic processes that involve oxidation or reduction in These plants increase and accelerate their growth and development activities, which are related to the increase in the activities of GA3, RNA, DNA and enzymes whose effects are reflected in improving plant standards (Qados and Hozayn, 2010), as the magnetic treatment of irrigation water improves growth. Vegetative crops and their ripeness before their dates, as well as their role in significantly reducing plant disease rates as well as improving the taste of agricultural products compared to plants irrigated with untreated water, which explains the reason for the increase in the proportions of active substances in the seeds of plants irrigated with magnetized water (Tables1, 2, 3, 4, and 5), thus providing plants with adequate nutrients for the appropriate stage of growth and metabolic processes, which in turn improves better rates than all plant growth criteria, which was achieved in the current study, as well as That is the reason for the fuck The increase in the proportions of the active ingredient in fenugreek seeds according to the intensity of the magnetic treatment of irrigation water can be explained on the basis of the appearance of new ingredient that have not been identified in other treatments, which has caused a variation in the increase or decrease of the percentages of active ingredient in the seeds according to the magnetic treatment of irrigation water.

The increase in the proportions of the chemical component of fenugreek seeds (the active substances) as a result of the treatment of fenugreek plants with foliar nanofertilizer is due to its role in increasing the speed of biological reactions and by the large surface area of nanoparticles that increase the speed of reactions leading to the production of growth materials, and given that each has its own enzymes that It increases the vegetative traits of the plant, encourages flowering and fruitful traits, and increases the production of the active ingredient in seeds (Zulfiqar *et a*l., 2019), and these results are in terms of curve with Abdel-Aziz *et al*. (2018a and b) on wheat, Wasaya *et al*. (2020) on the *Vignaradiata*.

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