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# Green synthesis of magnetic nano particles using novel plant extracts and its impact as fertilizers on *Helianthus annuus* and *Vicia faba*

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Green synthesis of metal nanoparticles is an efficient environment friendly approach due to its advantages properties compared with other traditional preparation methods. In this work natural extract of, *Mentha varidis* L, *Ocimum basilicum*, and *Vinca rosea* plants were used in magnetic nanoparticles ($Fe_3O_4$) preparation. FTIR, XRD, and TEM confirmed the successful formation of magnetic nanoparticles (MNPs) capped with different active constituents of plant extracts. The green synthesized $Fe_3O_4$ MNPs was applied in this study as a foliar fertilizer for *Helianthus annuus* and *vicia faba.* A pot experiment was conducted to investigate the growth of *Helianthus annuus* and *vicia faba*. Morphological and chemical analyses were done to evaluate the variation between the three used extracts. Promising results obtained show increase in both morphological characters and chemical composition for both studied plants by spring $Fe_3O_4$ MNPs using the three plant extracts. Plants group spired by $Fe_3O_4$ MNPs synthesis from *Ocimum basilicum* extraction recorded highest values, compared with other two plants extractions.

**Keywords: green synthesis, plant extract, foliar fertilization, *Helianthus annuus* , *Vicia faba.***

## INTRODUCTION

Nanotechnology is now an established and interesting field of applied science in many areas. Many applications in the field of biotechnology and agriculture (Rawat et al., 2018). The main features of the Nanoparticles (NPs) depending on its dimension in the range of 1–100 nm which act as a bridge between bulk materials and atomic or molecular structures (Kaushik et al., 2010). New formed substances give new characteristics with many advantages such small sizes, large surface area that depends on size (Darezereshki et al., 2010). Research on nanoparticles has become attractive due to its unique characteristics and their applications in a various fields.

One of the most important element for plant growth is Iron (Fe), which is the third most limiting nutrient for plant growth and metabolism, plays a significant role in various physiological and biochemical pathways in plants (Rout and Sahoo 2015). Additionally it serves as a must of many important enzymes such as cytochromes of the electron transport chain which is required for a wide range of biological functions. Moreover, Fe is involved in the synthesis of chlorophyll, and it is essential for the maintenance of chloroplast structure and function. (Gyana et al. 2015). In this work, we used magnetite nanoparticles (MNPs) which have great attention recently.

Many physical and chemical methods were recorded iron oxide nanoparticles synthesis (Laurent et al., 2010). One of the most recent methods for iron oxide nanoparticles synthesis is green synthesis. The green synthesis method of nanoparticles production has been proposed as a cost-effective, much easier, environmental safe, non-toxic compared with typical alternative to physico–chemical methods (Imtiyaz et al., 2016).

Preparation NPs using biological methods such plants or their extracts seems to be the best agents because they are available in environment, suitable for mass production of NPs and their waste products are eco-friendly (Lee et al., 2011) unlike some microbial extracts. The synthesis of $Fe_3O_4$-NPs has been suggested because of its unique properties such super paramagnetic biocompatible, easy degradation, and expected to be safe to humans and other organisms (Yew et al., 2016). 2

Many studies illustrate the ability of using fruits and various plant parts as waste materials for the green synthesis of $Fe_3O_4$ MNPs. (Venkateswarlu et al.,2013) used peel extract of plantain, (Mahdavi et al., 2013) synthesized magnetic iron oxide ($Fe_3O_4$) nanoparticles using seaweed, (*Sargassum muticum*). Moreover, (Basavegowda et al. 2014a) used leaf extract of *Perilla frutescens* to prepare nanoparticles. Additionally, (Basavegowda et al., 2014b) synthesized the NAPs from *Tridax procumbens* while (Latha and Gowri, 2014) used *caricaya papaya* leaf extract for the same purpose.

*Kappaphycus alvarezii*, seaweed was used for NAPs preparation from extract by (Yew et al., 2016). On the other hand, (Prasad et al., 2015) synthesized $Fe_3O_4$magnetic nanoparticles using watermelon rinds and (Maheswari et al., 2016) Synthesis of magnetite nanoparticles through leaf extract of *Azadirachta indica*.

More researchers had the same trend in nanoparticles synthesis, that (Gottimukkal, 2017) synthesized magnetite nanoparticles using green tea extract from leaves, while (Izadiyan et al., 2018) synthesized iron oxide nanoparticles using *Juglans regia* green husk extract.

Many other plants were used as non-toxic and efficient synthesis of iron nanoparticles mentioned by (Mandeep and Dimple, 2018) for biomedical applications.

In a previous work, (Ghasemi et al., 2006) studied the effect of iron on soybean and concluded that application of iron in low-iron soils can increase grain yield in soybean (Sala, 1999) is one of the pioneers researchers to illustrate the effects of magnetic nanoparticles in plants, showed an enhancement in both chlorophyll levels and photosynthesis rate in seven-day-old bean seedlings following the addition of 0.1% magnetite-based magnetic fluid in the culture medium.

In this work, two crops were studied, the first is *Helianthus annuus*, an annual growing, sunflower, is the common name, family Asteraceae. Sunflower is the world‘s fourth largest oil-seed crop and its seeds are used as food and its dried stalk as fuel. It is already been used as ornamental plant and was used in ancient ceremonies. Other medical purpose for pulmonary afflictions has been studied. Sunflower is used in dyes for the textile industry, body painting, and other decorations. For industrial uses, sunflower is used in making paints, cosmetics, manufacturing ethyl alcohol, phosphorous and potassium fertilizers, fuel production. Also sunflower is source of 3

Protein for human because of its high nutritional value, seeds contain vitamin A, and vitamins from the B group, vitamin E, and of minerals, there are calcium, phosphorus, iron and sodium. Other environmental uses such phytoremediation potential and energy production (Fernández-Luqueño et al., 2014).

The second studied plant is, *Vicia faba*, which is commonly known as faba bean or broad bean, belongs to the legume family, Leguminosae (also known as Fabaceae). Faba bean are tasty and nutritious seeds are consumed from green to dry, and pods are eaten when young. The grain is one of the most important winter crops in the Middle East. Faba bean is a common breakfast meal in the Middle East, Mediterranean region, China and Ethiopia. Faba bean is good source of fiber, folate, phosphorus, and potassium. They also contain nessary fatty acids, protein ,betacarotene, and vitamin C. Like other legumes, Faba bean is high in protein due to its ability to fix nitrogen from the air through a symbiotic relationship with bacteria found in root nodules. Faba bean contains small amounts of several possible antinutritional factors; however, their effects are less acute, and protease inhibitors are at much lower (2%) concentrations compared to soybeans (Singh et al., 2012).

In this study, three plant leaf extracts *Mentha varidis*.L, *Ocimum basilicum*, and *Vinca rosea* were used to evaluate the green synthesis of metal nanoparticles as an efficient environment-friendly approach. Application of the biosynthesized iron oxide nanoparticle strategy to examine possible improvement the growth parameters of *Helianthus annuus* and *Vicia faba* were studied. We examined the effects of the biosynthesized iron ($Fe_3O_4$ nanoparticles (NPs) on the plant growth of both studied plants, as well as the levels of the active constituents, with the aim of developing a technical approach for the agricultural application of economical nano-materials.

## MATERIALS AND METHODS

### Synthesis of magnetic iron oxide nanoparticles ($Fe_3O_4$):

The ($Fe_3O_4$) magnetic nanoparticles were prepared chemically by co precipitation method. The (Fe3O4) magnetic nanoparticles were prepared based on the co precipitation of $Fe^{3+}$ and $Fe^{2+}$ with a molar ratio of 2:1 respectively under aqueous ammonia (0.3mol/L) according to (An et al., 2004) as follows: 4

Briefly, mix and dissolve 2 g of ferrous chloride tetrahydride and 3.25 g ferric chloride in 50 ml distilled water under aqueous ammonia (25%, 10 ml) and vigorous stirring in a closed flask. Aqueous ammonia (0.3mol/L) was titrated until pH reach to 11 (Zhang et al., 2006), (Jiang et al., 2004), and (Jiang et al., 2003). The solution became black due to the formation of Fe3O4 particles. The sample was kept reacting at 50 oC for 30 min under vigorous stirring .The black mixture was then aged for 1 h. After that, the precipitate was separated from liquor with the magnet. Finally, the $Fe_3O_4$ magnetic nanoparticles washed with distilled water until the pH value descended to 7.0 and were collected and dried at 60oC. Synthesis of magnetic iron oxide nanoparticles ($Fe_3O_4$) using plant extract.

Two solutions were prepared, the first one (solution 1) was prepared by dissolving 2 g of ferrous chloride tetrahydrate and 3.25 g ferric chloride in 50 ml distilled water. The second one (solution 2) is prepared by adding 10 ml of aqueous ammonia (25%) to 50 ml of plant extract. Solution 2 was added drop wise to solution 1 until the solution became dark due to the formation of magnetic nano-particles capped with constituents from the plant extract. The nanoparticles were collected and dried as previously mentioned and capping constituents was defined using FTIR.

### 2.2 Characterizaion of Fe3O4 magnetic nanoparticles:

The crystal structure and phase purity of the synthesized magnetic nanoparticles were established by powder x-ray diffraction (XRD) analysis. XRD was done using (X-ray diffractometer XPERT-PRO-PA Nalytical Netherland) at room temperature (25ºC) with scan continuous scan type. The X-ray anode source utilized was Cu target with settings of 30kv and 30 MA.The morphology of the nanostructures was studied using a transmission electron microscope (TEM) EFI Netherland, Modal Tecani G20, super twin, double tilt with applied voltage 200kv, magnification range up to 1000,000 X and Gun type LaB6 Gun.

FTIR was used to define the nanoparticles capping compounds from the plant extract. The infrared spectra (4000.6–399.1 $cm^{-1}$) were recorded on a Fourier transform infrared spectrometer JASCO FT/IR-4100. 5

### 2.3 Plant extract Prepartion

*Mentha varidis*.L, *Ocimum basilicum*, and *Vinca rosea* leaves were collected from the fields. The leaves were washed and the cleaned leaves were air dried for 7 days and then ground to a fine powder. 200 mg of powdered leaf was dispensed in 100 ml of sterile distilled water and boiled for one hour at 80ºC. Then the leaf extract was collected in separate conical flasks by standard filtration method and stored in dark colored bottles till further use.

### 2.4 Pot experiment

A pot experiment was conducted to determine the efficiency of using the biosynthesized iron oxide nanoparticle as fertilizer source, on sunflower and faba bean. Plants were divided into five groups. Control plants without any additions, group recived iron oxide nanoparticle fertilization, the other three groups received *Vinca rosea*, *Ocimum basilicum*, and *Mentha varidis*.L leaves extract with iron oxide nanoparticle as fertilization source. Each group had three replicates, fertilization was applied by sprying on plant leaves, once per week for one month which is the duration of the experiment. Plant shoot height (cm), root length (cm) and leaves number were measured for both sunflower and faba bean plants. The way of fertilizer application is the most important, that plants uptake and translocate elements onto the different parts (Khanm et al. 2018). Foliar application method was tested many years ago as effective method help plants to absorb water and nutrients efficiently (Fernández and Eichert, 2009).

### 2.5 Chemical Analysis

Total sugars was determined colorimetrically according to (Dubois et al., 1956).Total Protein Procedures and sample handling are described in the Official Methods of Analysis of AOAC (1995). 6

### 2.6 Statistical analysis

All treatment experiments were repeated three times. The main control seedlings were supplied only with distilled water. Average values and standard deviations were calculated; t-test was applied to assess the statistical significance of the differences between the control and magnetic nanoparticle treated plants using originPro. The measured parameters are M: Mean SD: Standard Deviation RSD: Relative Standard Deviation

## RESULTS AND DISCUSSION

### Synthesis of magnetic iron oxide nanoparticles ($Fe_3O_4$) and Characterizaion

Fig (1) illustrate that the morphology of nanoparticles appears mainly spherical (size about 10 nm) but some may be oval. This variation is common due to the capping by protein of biomolecules.

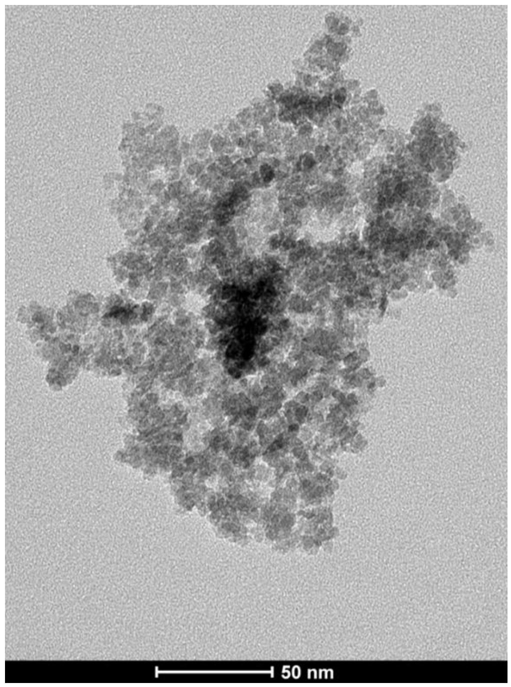


**Figure (1): TEM micrograph of green synthesized magnetic nanoparticles ($Fe_3O_4$ at room temperature using *Ocimum basillicum* L. leaf extract.**

The crystal structure and phase purity of the prepared iron oxide nanoparticles were identified by measuring the XRD pattern as shown in Fig (2). The lattice constants are equals a=b=c and found to be 8.383 Å, confirm the formation of a cubic structure. The strongest reflection that proceeds at 2θ=35.5 is characteristic of such cubic phase. The diffraction peaks at 30, 35.4, 43, 53.4, 56.9, and 62.5° indexed to planes (220), (311), (400), (422), (511) and (440) which corresponded to a cubic unit cell. The strongest reflection that proceeds from the 311 plane, characteristic of such cubic phase (Kim et al. 2003) . The two peaks at 2θ=32.7 and 40.1° are characteristics to the cubic crystal structure of salammoniac ($NH_4Cl$) (Burke, 2008) . The lattice constants are equals a=b=c and found to be 3.878 Å. Salammoniac is component which is natural, mineralogical form of ammonium chloride.

In Fig (3), the spectrum showed clear absorption peaks located 3,430, 1,630, 1400, and 570 $cm^{-1}$. The absorption peak at 3,430 $cm^{-1}$ possibly assigned to OH stretching in alcohols and phenolic compounds. It was found that eugenol is the main component in the essential oils of *Ocimum basilicum* extract (Hiltunen R and Holm Y, 2003) . The absorption band at 1630 cm-1 can be attributed to C = C stretching vibrations of an 7 aromatic ring. This C = C stretching may be due to terpenes hydrocarbons found in the essential oils of *Ocimum basilicum* (Dev et al, 2011). The peak at 1400 cm-1 may be due to OH bending vibrations of polyols present in leaf extract. The FeO band of $Fe_3O_4$ located at 570 $cm^{-1}$ (Atta et al, 2014).

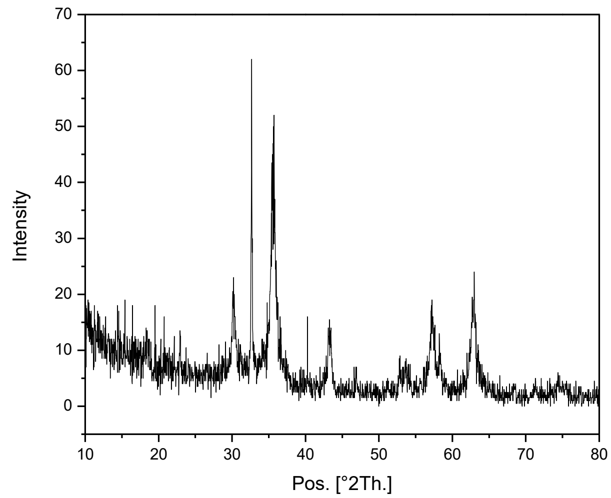


**Figure (2): XRD spectrum of the green synthesized magnetic nanoparticles ($Fe_3O_4$) showing the main peaks of the cubic crystal planes.**

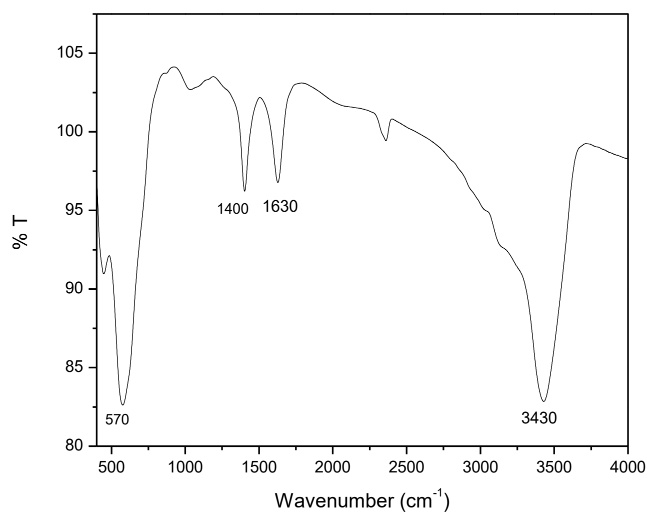


**Figure (3): FT-IR spectrum of biosynthesized magnetic nanoparticles using *Ocimum basillicum* leaf extract.**

### 3.2 Morphological analysis and chemical composition

Fig (4), illustrate the effect of different $Fe_3O_4$ NPs applications on sunflower and faba bean shoots height, root length and leaves number. The application of $Fe_3O_4$ NPs was added separate and when prepared with the three plant extracts *Mentha varidis*.L, *Ocimum basilicum*, and *Vinca rosea.* Measured growth parameters were estimated through foliar spray application. The figure shows increase in sunflower and faba bean shoot height, the highest incremant recorded when using the extact of *Ocimum basilicum* and $Fe_3O_4$ NPs . Same attidue was reported in root length and leaves number, higer redings were noticed in *Ocimum basilicum* and $Fe_3O_4$ NPs application, while increments in faba bean roots were more pronounced than sunflower. This may be due to vegetation growth nature of *vicia faba*.

Statistical analysis (M: Mean SD: Standard Deviation RSD: Relative Standard Deviation) represent in (table 1) indicated that the *Ocimum basilicum* extraction with $Fe_3O_4$NPs application formed the best combination compared with other treatments. This is clear from the highest recorded values for plant height, root length and leaves No. *Mentha varidis* extraction with $Fe_3O_4$ NPs was the second effient treatment followed by *Vinca rosea* with $Fe_3O_4$ The three extracted plant affected positivly on sunflower and faba bean morphological charctes compared with control or with single addition of $Fe_3O_4$.

The way of fertilizer addition which is foliar, increase the precipitation of $Fe_3O_4$NPs in the leaves after foliar spray as insoluble oxides forming complexes with phytoferritin, an iron-binding protein found in leaves which enhancing plant growth(Elfeky et al.,2013) . 8

Many other benefits illustrated by (Voogt et al. 2013) such in some microelements in general Fe, Mn, Zn, Co fertilization it is better to add fertilizers as foliar addition due to poor availability due to high pH (calcareous soils, salinesoils, leached soils such as sand or peat). In Fe especially foliar addition is more recommended to cure chlorosis due to high pH and insufficient root development in greenhouse crops.

Previous studies illustrated the role of nano fertilizer.

(Nazaran et al., 2009) found that foliar application nano iron fertilizer enhances quantitative and qualitative characteristics of wheat compared with control, untreated. Moreover (Elfeky et al., 2013) reported the significant effect of $Fe_3O_4$ NPs foliar application on sweet basil plants which increased plant height, number of leaves/plant.

(Parandeh et al., 2011) expressed that high concentrations of nano Fe were significantly increased basil plants growth while (Nurzynska et al., 2011) and (Ghahremani et al. 2014) concluded that applying nano calcium chelate fertilizer with nano potassium chelate fertilizer, improve basil performance in comparison with control treatment.

In previous work,(Tarafdar et al., 2014) suggested that application of zinc nano-fertilizer on pearl millet (*Pennisetum americanum* L.) significantly improved shoot length, root length, root area, chlorophyll content, plant dry biomass, and increased the grain yield by 37.7 %. On the other hand spray of $nTiO_2$ increased grain number per spike up to 10 % over to control. On the hand (Jhanzab et al., 2015) concluded that in wheat plants, silver nano particles significantly enhanced leaf area, yield and N, P and K use efficiency. Additionally, increased chlorophyll content produced more number of grains.

(Ousefzadeh and Sabaghnia, 2016) indicated that application of iron nano-fertilizer increased the dragonhead's *Dracocephalum moldavica* dry mass yield and essential oil yield cultivated in semiarid region conditions.

Moreover, (Abdel Nabi, 2017) found that applying foliar spraying on head lettuce plants with nano form of lithovit affected positively the measurements of head lettuce and gave the highest values of yield and quality parameters. The measured parameters were, leaf area, total yield/fed, dry matter percentage in inner and outer leaves, total soluble solids (TSS), total sugars, total carbohydrates and crude protein percentages, 9

Chlorophyll a, b and total chlorophylls concentration Fmentha, under the studied conditions.

The application of nano Zn oxide particle and $ZnSO_4$ (ZnO NPs) by (Khanm et al., 2018) on tomato plants as foliar application, improved yield and Zn content in tomato plant. This may be due to that nano ZnO form is absorbed by plants to a larger extent unlike bulk $ZnSO_4$. Nano ZnO has proved to enhance Zn absorption because of high surface area to volume ratio. The significant increase in growth parameters may be due to the precipitation of $Fe_3O_4$ NPs on the leaves after application. Insoluble oxides forming complexes with phytoferritin, an iron-binding protein found in leaves (Bienfait HF and Van DM. 1983).

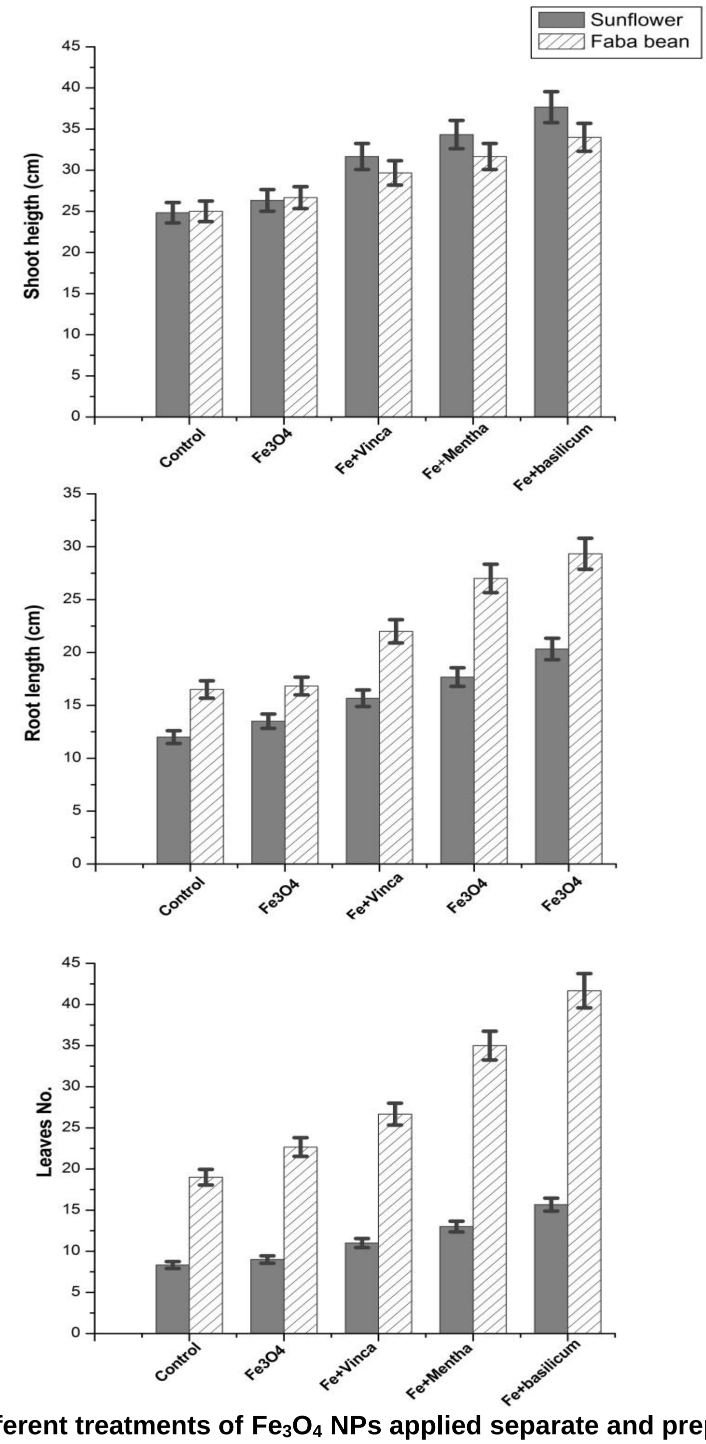


**Figure (4) Effect of different treatments of $Fe_3O_4$ NPs applied separate and prepared with the three plant extracts *Vinca rosea*, *Mentha varidis.*L and *Ocimum basilicum* on sunflower and beans growth parameters through foliar spray.**

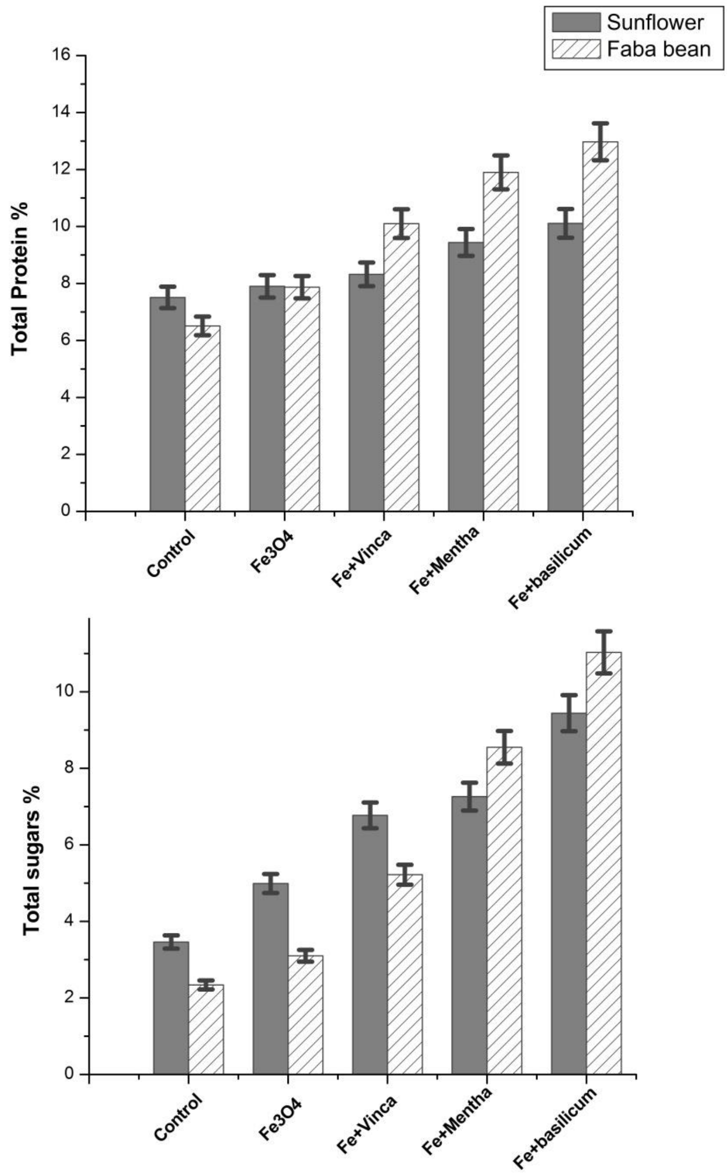


**Fig (5) Effect of different treatments of $Fe_3O_4$ NPs applied separate and prepared with the three plant extracts *Vinca rosea*, *Mentha varidis.*L and *Ocimum basilicum* on sunflower and beans on total protein % and total sugars % through foliar spray .**

Consequently, low mobility of iron after binding to phytoferritin in leaves leads to higher contribution in chlorophyll synthesis by foliar spray. This may be due to the increase in chlorophyll and carbohydrate synthesis (Said-Al Ahl et al., 2010) and (Jia et al., 2012). These results suggest that the iron NPs in these samples induced an extreme and extra increment in essential oil composition in plants compared to the control.

**Table 1: Statistical analysis of shoot height (cm), root length (cm) and leaves number for sunflower and faba bean plants fertilized using studied treatments. M: Mean SD: Standard Deviation RSD: Relative Standard Deviation.**

| | Growth character | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Shoot Plant height (cm) | | | | | | Root length (cm) | | | | | | Leave No. | | | | | |
| | Sunflower | | | Faba bean | | | Sunflower | | | Faba bean | | | Sunflower | | | Faba bean | | |
| | M | SD | RSD | M | SD | RSD | M | SD | RSD | M | SD | RSD | M | SD | RSD | M | SD | RSD |
| Control | 24.83 | | | 25.00 | | | 12.00 | | | 16.50 | | | 8.33 | | | 19.00 | | |
| $Fe_3O_4$ | 26.33 | 0.75 | 0.028 | 26.67 | 0.84 | 0.031 | 13.50 | 0.75 | 0.055 | 16.83 | 0.165 | 0.009 | 9.00 | 0.33 | 0.036 | 22.67 | 1.83 | 0.081 |
| Fe+Vinca | 31.67 | 2.93 | 0.092 | 29.67 | 1.93 | 0.065 | 15.67 | 1.50 | 0.095 | 22.00 | 2.518 | 0.114 | 11.00 | 1.13 | 0.102 | 26.67 | 3.13 | 0.117 |
| Fe+Mentha | 34.33 | 3.86 | 0.112 | 31.67 | 2.58 | 0.081 | 17.67 | 2.15 | 0.121 | 27.00 | 4.299 | 0.159 | 13.00 | 1.82 | 0.14 | 35.00 | 5.94 | 0.169 |
| Fe+basilicum | 37.67 | 4.81 | 0.127 | 34.00 | 3.26 | 0.095 | 20.33 | 2.95 | 0.145 | 29.33 | 5.199 | 0.177 | 15.67 | 2.68 | 0.171 | 41.67 | 8.27 | 0.198 |

M: Mean SD: Standard Deviation RSD: Relative Standard Deviation

**Table 2: Statistical analysis of protein (%) and carbohydrate (%) for sunflower and plants faba beans fertilized using studied treatments. M: Mean SD: Standard Deviation RSD: Relative Standard Deviation.**

| Chemical composition | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Total Protein % | | | | | | Total sugars % | | | | | |
| | Sunflower | | | Faba bean | | | Sunflower | | | Faba bean | | |
| | M | SD | RSD | M | SD | RSD | M | SD | RSD | M | SD | RSD |
| Control | 7.51 | | | 6.51 | | | 3.46 | | | 2.34 | | |
| $Fe_3O_4$ | 7.9 | 0.19 | 0.024 | 7.87 | 0.68 | 0.086 | 4.99 | 0.76 | 0.152 | 3.1 | 0.38 | 0.122 |
| Fe+Vinca | 8.32 | 0.33 | 0.039 | 10.1 | 1.47 | 0.146 | 6.77 | 1.35 | 0.199 | 5.22 | 1.21 | 0.231 |
| Fe+Mentha | 9.44 | 0.72 | 0.076 | 11.9 | 2.06 | 0.173 | 7.26 | 1.50 | 0.206 | 8.55 | 2.40 | 0.280 |
| Fe+basilicum | 10.11 | 0.97 | 0.095 | 12.97 | 2.41 | 0.185 | 9.44 | 2.03 | 0.215 | 11.03 | 3.29 | 0.298 |

M: Mean SD: Standard Deviation RSD: Relative Standard Deviation

Different researchers suggested that micronutrients play critical roles in the synthesis of chloroplast proteins and thus may interfere with chlorophyll synthesis. It has been revealed that lack of micronutrients inhibit the formation of chlorophyll through inhibition of protein synthesis (Marschner, 2012).

(Janmohammadi et al., 2016) proved that foliar application of the nano micronutrient application of Fe and Zn improved barley grain number up to 11 % and 13 %, respectively, in compared to control.

Fig (5) presents effects of different applied treatments on total protein and total sugars percentages in the two studied plants. As growth parameters trend, the extact of *Ocimum basilicum* with $Fe_3O_4$ NPs recorded highest values followed d by *Mentha varidis* extraction with $Fe_3O_4$ NPs was the second effient treatment follwed by *Vinca rosea* with $Fe_3O_4$ .

Sunflower control and $Fe_3O_4$ recorded nearly the same values while the increments was clear for faba bean. Generally, faba bean plants recorded values higher than sunflower. 10

Statistical analysis (M: Mean SD: Standard Deviation RSD: Relative Standard Deviation) represent in (table 2) indicated that M, SD, RSD values increased following the same mentioned routin, highest valuses recorded by *Ocimum basilicum* with $Fe_3O_4$ NPs then *Mentha varidis* extraction with $Fe_3O_4$NPs followed by *Vinca rosea* extraction with $Fe_3O_4$NPs. Application of $Fe_3O_4$ NPs recorded values less than *Vinca rosea* extraction but higher than control treatment.

This result with in agreements with previous works, (Roshanak et al., 2012) who applied nano-iron foliar application spraying on cowpea increase the yield quantity and improved protein quality which is associated to increasing tolerance to drought stress.

(Sheykhbaglou et al., 2014) indicated that the foliar application of soybean plants using nano-iron oxide leads to enhancement in linoleic acid (up to 33.83%), protein oleic acid (20.45%) and and lipid (up to 25.40%) percentage in contrast of control treatment. Additionally, the recommended application positively enhance seed quality, chlorophyll contents in soybean seed and could have an antioxidant role in soybean oil.

Same results were reported by (Panjtan,1999) indicated that it is about the positive effect of iron on increasing magnesium content of peanut and iron on increasing phosphorous content in peanut kernels. Additionally, the storage form of phosphorous in seeds is phytic acid (phytin) and it seems that increasing of it, have major efficacy in seeds germination rate. Moreover that iron has positive impact on increasing of calcium content of peanut kernels. (Marschner, 1995) wrote that iron had not significant effect on calcium content of soybean seeds, but in the present study we found that iron had positive effect on seeds calcium content. Usage of nano-iron oxide solution explained 89 percent of changes of total chlorophyll content in soybean seeds. In attention to regression equation it is observed that the maximum amount of total chlorophyll (0.188 Mg g-1) was obtained by usage of 0.59 g $L^{-1}$ of nano-iron oxide. As the two crops soybean and faba bean are legumes.

## CONCLUSION

The obtained results from this work indicated that foliar spray applications for the three used plant extractacts (*Mentha varidis*.L, *Ocimum basilicum*, and *Vinca rosea*) , affected positively on sunflower and faba bean Plant shoot height (cm), root length (cm) and leaves number compared with control and single addition of with $Fe_3O_4$. *Ocimum basilicum* extraction with $Fe_3O_4$ NPs application formed the best combination compared with other studied treatments. Additionally, total protein and total sugars percentages were increased by applying in the two studied plants

According to the previous results we could recommend these application as safe method for *Helianthus annuus* and *Vicia faba* fertilization which enhance both vegetation and also protein and total sugars which increase the nutritional value for both two crops, this may be a start for extra work using local plants extractions in Agriculture crop fertilization.

## CONFLICT OF INTEREST

Dr Manar Hassan and Dr Souad A. El-Feky the authors of the paper entitled Green synthesis of magnetic nano particles using novel plant extracts and its impact as fertilizers on *Helianthus annuus* and *Vicia faba* declare that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

Nanoparticles preparation and data analysis was done by Dr El Feky, Also for statistical analysis.

Plant extract preparation, pot experiment, growth and chemical analysis and interpretation were done by Dr Hassan. Manuscript preparation and editing was done by all authors, all authors read and approved the final version.



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