International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 08, 2020
ISSN: 1475-7192

Influence of Selenium and Manganese Nanoparticles Prepared by Laser Induced Plasma on Levels of the Thyroid Gland (T3, T4 and TSH)

[1]Rafal H. Jassim, [2]Kadhim A. Aadim

Abstract--*In this study, thin films were prepared by laser induced plasma (LIP) method using a pulsed laser (Nd: YAG) of wavelength (1064nm) at the temperature of the room and in the vacuum and the effect of different energies (650 mJ-950 mJ) to study the structural and structural properties (XRD, AFM). Similarly, selenium and manganese nanoparticles were manufactured by laser-induced plasma and also using pulsed lasers upon collision with solid target atoms. The effect of these nanomaterials on levels of the thyroid gland (T3, T4 and TSH) was observed under two doses of each component (1mg/kg, 4mg/kg).The relative weight of mice was observed for each group and the effect of selenium nanomaterials than manganese nanomaterial was affected on the weight of rats, i.e. on the metabolism process.It turns out that selenium nanomaterial is the most influencing metabolism and weight of manganese nanoparticles.*

Key words--*Manganese NPs and Selenium NPs, Thyroid hormone, PLD, PLAL, XRD, AFM.*

I.INTRODUCTION

Nanotechnology is a modern field of science that plays a dominant role in everyday aspects of life. Nanotechnology deals with the production, handling and use of nanometer-sized material[1].Various metallic nanomaterials are currently produced using copper, zinc, titanium, magnesium, gold, alginate, and silver. Nanoparticles are used for a variety of purposes, from medical treatments to the use of solar and oxide fuel batteries for energy storage in various branches of industry, to the wide incorporation into various materials for everyday use, such as cosmetics or clothes [2]..Nanoparticles may be chemically or biologically synthesised. Many adverse effects due to the presence of some toxic chemicals absorbed on the surface were associated with chemical synthesis methods. Eco-friendly alternatives to chemical and physical methods are biological methods for synthesizing nanoparticles using micro-organisms[3,4], enzymes[5], fungi[6], and plants or plant extracts[7,8].

Selenium is an element whose trace amounts are essential for life and has gained a considerable attention in both human, technical and agricultural field of science due to its piezoelectric, photoelectrical, semiconducting, catalytic activities but also its bioactivity [9, 10].Manganese oxides can be applied in catalysts, molecular-sieves, ion-sieves, batteries, magnetic materials as well as other applications such as water treatment, imaging contrast agents due to their excellent physicochemical properties [11]. It is possible to obtain pure nanoparticles, and to capture all nanoparticles in liquid. As ablated particles pass through the plume induced by laser ablation in liquid where the temperature and pressure are very high, the production of nanoparticles with new optical, electrical and mechanical properties is expected [12]. The thyroid is an endocrine gland, whose follicular cells synthesize and secrete triiodothyronine (T3) and thyroxine (T4) metabolic thyroid hormone these

[1]*Department of Physics, College of Science, University of Baghdad/Iraq*
[2]*Department of Physics, College of Science, University of Baghdad/Iraq, E-mail: kadhim_adem@scbaghdad.edu.iq*

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

hormones play an important part in maintaining homeostasis in the body. They regulate lipid and glucose metabolism, facilitate metabolic adaptations in response to energy intakechanges, and control basal metabolism, thermogenesis, as well as oxidative metabolism[13, 14].T4 is the main hormone produced by the thyroid gland and represents about 93% of the total quantity of secreted hormones.Nevertheless, T3 is the most metabolically active hormone with a 10-15 fold increase in thyroid hormone receptor affinity compared to T4. Therefore, intracellular conversion of T4 to T3 by deiodinase enzymes is necessary to ensure high thyroid hormone efficiency [15].

II. DETAILS OF EXPERIMENT PART

2.1Prepare the thin films

In this work, the thin films were prepared by pulsed laser (Nd: YAG) with wavelength (1064 nm) and under vacuum ($2.5 \times 10^{-2}\ mbar$) and at room temperature under the influence of different laser energies (650 mJ-950mJ), where the laser energy is focused on the target where the material evaporates on the bases From glass in the plasma columnas shown in the figure(1) for the purpose of studying the structural and structural properties (XRD, AFM) of the thin films prepared for selenium and manganese.

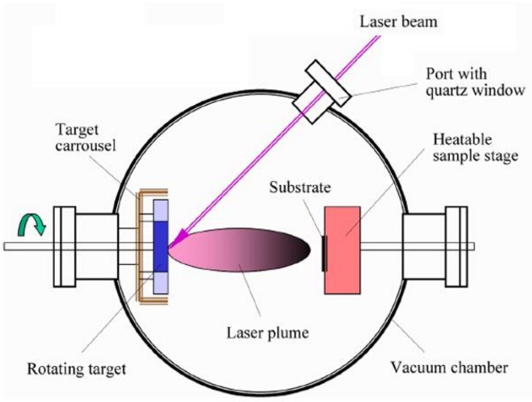

Figure 1: Schematic of pulsed laser deposition system

2.2 Manufacturing nanomaterials in a way Pulsed Laser Ablation in Liquid (PLAL)

Figure (2) shows the experimental based on the pulsed laser ablation in liquid environment method. Nanoparticles were synthesized by pulsed laser ablation of Se and Mn target placed at the bottom of a glass vessel containing 3 ml of ionic water. Ionic water height above the target was 10mm. The target was irradiated by Nd:YAG laser fluencies for 950 pulses.During the laser irradiation process the vessel was rotated so that the nanoparticles formed did not shield the laser radiation from reaching the target surface. After the ablation process, the transparent becomes ionic water colored in brown for the Mn target and red when irradiation for the Se target which gives the expectation of NPs formation.In PLA, laser parameters such as fluencies, wavelength, and pulse duration can monitor the size of nanoclusters.

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

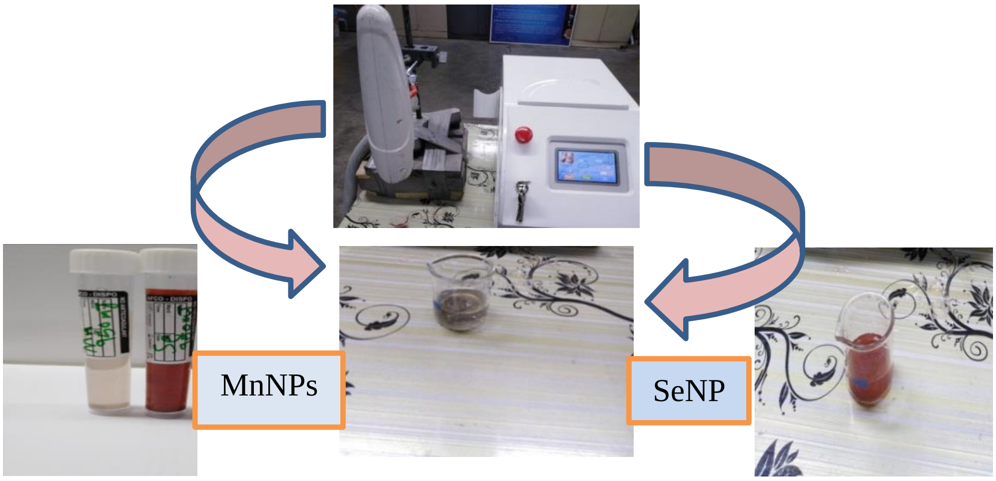

Figure: 2 illustrates the method of producing nanomaterialsby using PLAL

In vivo study

The study was conducted on 20 adult female rats and was divided into 5 groups, each group contains 4 animals, the weight of each animal was calculated before the dose process and considered a zero day before any exposure process and the weight measurement continued throughout the study period to calculate the relative weight of each group by applying the equation (1) [16]. Also, the percentage of thyroid hormone (T3, T4, TSH) was calculated by drawing blood from each animal and each group as shown in Figure (3) before the dose. The first and second groups were dosed with a dose of respectively (1ml/Kg, 4ml/kg)or (11.4, 45.362) ppm from the nanoparticles selenium, the third and fourth groups were dosed(1ml/kg, 4ml/kg) or equivalent (9.05, 36,2) respectively of the nanoparticles manganese elementand fifth group was the control group [17,18] as shown in Figure (3)**.**Immediately after the dosing process, blood was drawn from all animals for all groups and the thyroid hormone level was measured in the blood (T3, T4, TSH) and the hormone was repeated weekly by 5 weeks, and the rate of increase or decrease in the percentage of the hormone in the blood and the impact of nanomaterials on it was also examined. The first and last days in the study period to observe the effect of the aforementioned nanomaterials on white and red blood cells and platelets, as well as the cellular toxicity of the nanomaterials under study was measured for several concentrations.

$$W_R = \frac{W(d_i)}{W(d_0)} \quad \text{----------} \quad (1)$$

Figure 3 adult female rats illustrate a- the method of drawing blood b- the dose method

III. RESULTS AND DISCUSSION

3.1. XRD of Manganese and Selenium Nanoparticles:

Figure (4) it is shown for The Se film is amorphous in nature and after annealing with a temperature (373 K) .The structure of the thin film showed a polycrystalline Hexagonal system for Se and increasing in intensity at orientation along (101) and all Se peaks results are found in agreement with the [19].

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

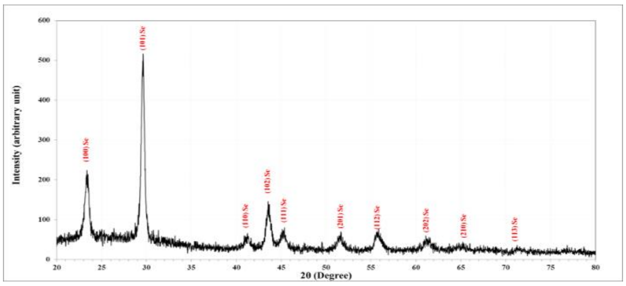

Figure 4: XRD patterns of the Se thin film using LIP technique with number of pulse =100 shots and annealed at 373k

The figure (5) show X-ray diffraction pattern for Mn powder can observe a polycrystalline cubic systemand preferred trend of growth (330) for Mnthis result is in agreement with[20] and the Mn film is being amorphous structure. The calculated crystalline size decreases for the main peak as laser energy increase this result is in agreement with [21].

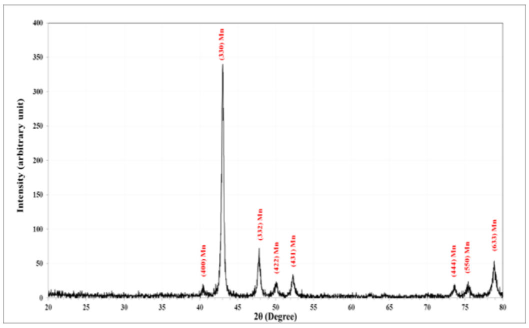

Figure 5: XRD patterns of Mn Powder

3.2 AFM of Manganese and Selenium Nanoparticles

3D AFM images and granularity accumulation distribution chart of (Se and Mn) thin films deposited on glass substrate synthesized with different laser energy and number of shot as figure(6 and 7). These figures shows the atomic force microscopy images and their granularity accumulation distribution for pure (Se and Mn) thin films deposited by pulses laser on glass substrate using different energies (650, 750, 850, and 950) and number of pulse is 100 pulses .It is noted from the measurements that average diameter decreases with increasing laser energy this result similar with aresult [22,21].

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

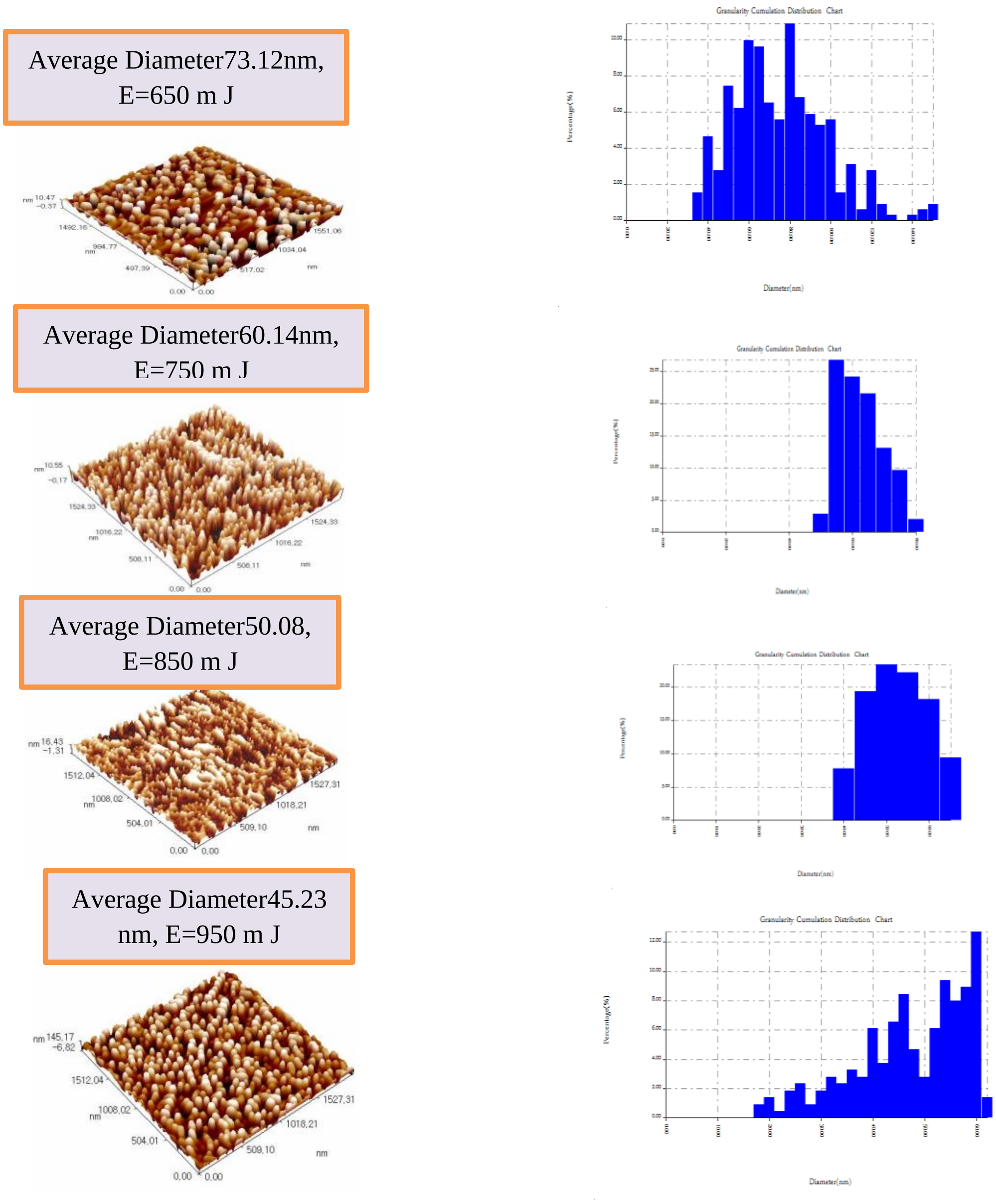

Figure 6: 3D AFM and their granularity accumulation distribution for Se thin film prepared by PLD with different laser energy and annealed T=373 K

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

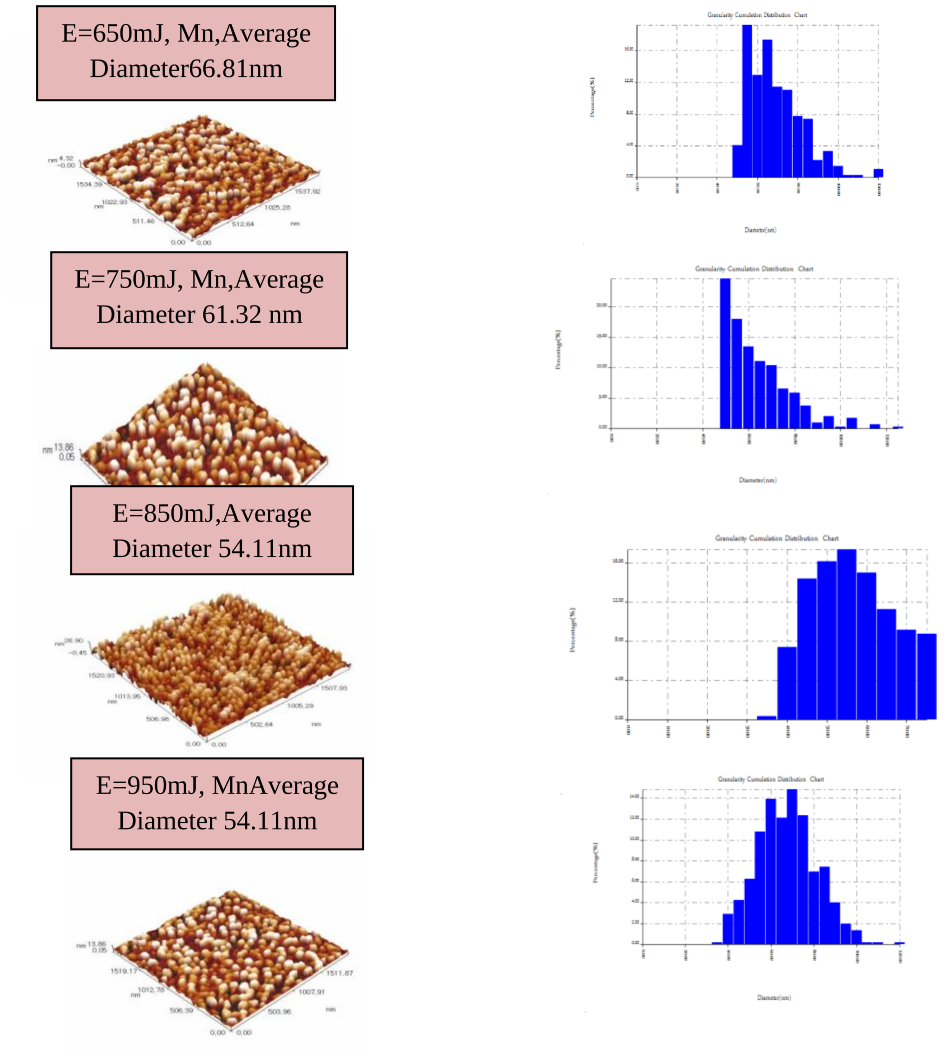

Figure 7: 3D AFM and their granularity accumulation distribution for Mnthin film prepared by PLD with different laser energy at R.T .

The Effect of Nanomaterials on the Thyroid gland

The three hormones (T3, T4 and TSH) were monitored for a period of 45 days by the rate of blood testing for each week. We observe from the forms a clear rise in the levels of hormones (T3 and T4) in the third and fourth week (the exposure period and after the dose) and then we notice a gradual decline of these hormones after one week of leaving the dose for all substances Nanoparticles. As for the selenium nanoparticles also had a clear effect on the levels of hormones for maximum doses (1.5, 71.8) more than minimum doses (1.41, 67.96) in relation to (T3 and T4) respectively and decrease in hormone (TSH) when increasing the nanomaterial and was better response to maximum doses (1.67) better than minimum doses (0.133), as it was found in agreed with other researchers' studies that showed an important role for selenium in controlling thyroid hormones [23,24].The effect of manganese particles was shown on the levels of hormones that had the lowest impact of the maximum and minimum doses (1.5, 72.9) and (1.41, 56.9) respectively, in relation to the hormone (T3 and T4) of the maximum and minimum dose (0.17, 0,12), as shown in the figures (8) and (9).

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

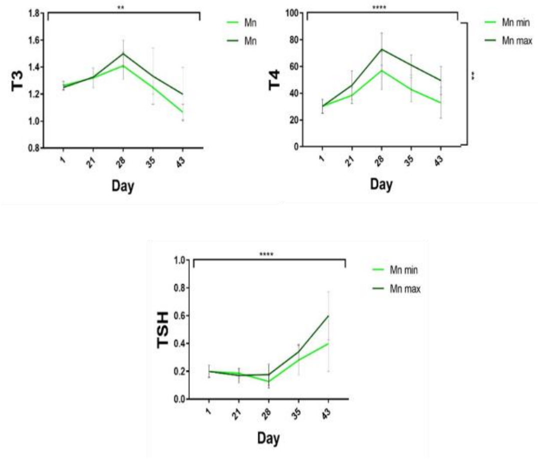

Figure 8: illustrates thyroid hormone (T3, T4, TSH) of Manganese nanoparticles for low and high doses

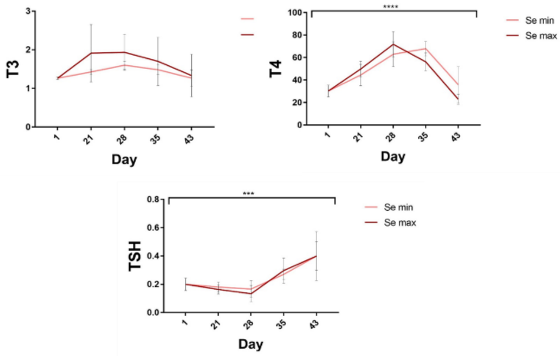

Figure 9: illustrates thyroid hormone (T3, T4, TSH) of Selenium nanoparticles for low and high doses

From the observation of Figure (10) which represents the weight curve of rats throughout the study period of the elements for all nanoparticles, it shows that when the thyroid hormone activity increases T3, T4 the rats ’weight decreases, which indicates an increase in metabolism and when the hormone descends led to the return of the animal’s weight to increase and return to its normal position In metabolism [25]. If the groups were compared with the control group, we note that the rats continued to gain weight without any decrease

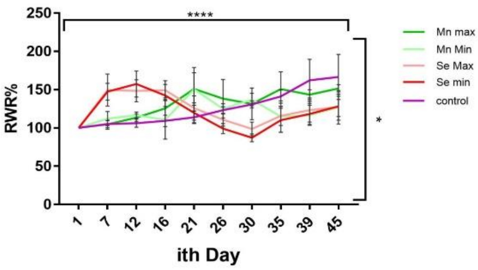

Figure 10 Hypothyroid hormone (T3, T4, TSH) shows the nanoparticle Selenium and nanoparticle Manganese for low and high doses

Figure (11) shows The effect of nanomaterials on blood components (white and red blood cells and platelets) and found that there is no effect on them and this is an indication that it does not affect, which indicates no negative effect on the blood components this result is in agreement with [26].

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020

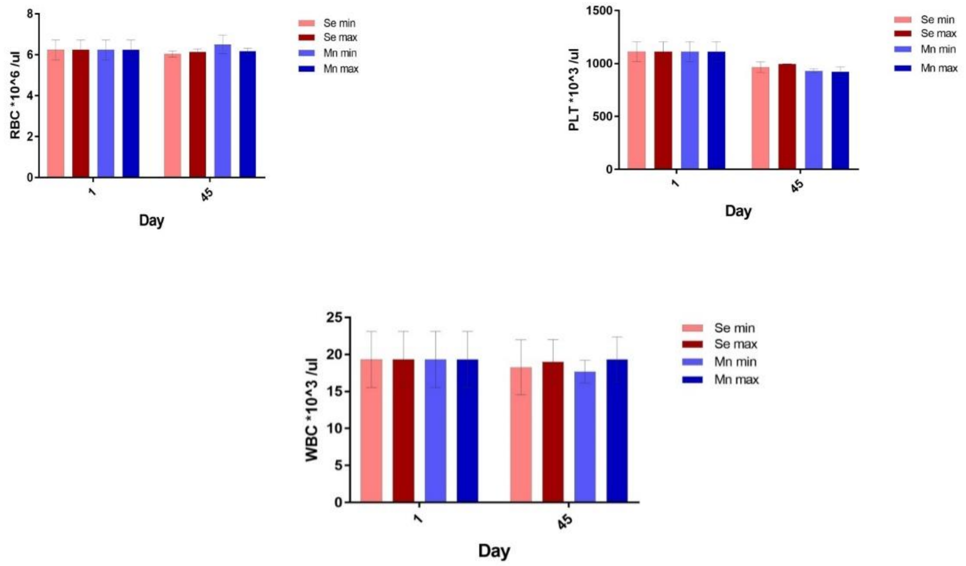

Figure 11 The effect of Selenium and Manganese nanoparticles on blood components (white and red blood cells and platelets)

IV. CONCLUSION

1. Nanoparticles affect the thyroid gland, when increasing the gland lead to a decrease in weight an increase in TSH and a decreases in T_3 and $T_4$and vice versa.
2. The XRD characterization show Se have wurtzite type polycrystalline thin film with a hexagonal system, while Mn have wurtzite type polycrystalline thin film a cubic system.
3. AFM investigation shows the Average Roughness and RMS increase with increasing the energy, while the Average Diameter deacrease with increasing the laser energy
4. We conclude some nanomaterials that could be used in the near future in the treatment of hypothyroidism

Acknowledgements

We thank University of Baghdad, College of Science, Department of Physics, Plasma Physics Lab. for supporting this work.

REFERENCES

1. Kavitha, K.S., Syed Baker, Rakshith, D.,Kavitha, H.U., YashwanthaRao, H.C.,Harini B., PandSatish, S." Plantsas green source towards synthesis ofnanoparticles" *Int. Res. J. Biol. Sci.*,2(6), (2013): 66 76.
2. Dubchak S., Ogar A., Mietelski J.W. and Turnau K., Influence of silver and tianium nanoparticles on arbuscularmycorhiza colonization and acumulation of radiocaesium in Helianthus anus, *Span. J. Agric. Res.*, **8(1), (2010)**:103-108.
3. Klaus T., Joerger R., Olsson E. and Granqvist C.G., Silver- Based Crystalline Nanoparticles, Microbially Fabricated, *J. Proc. Natl. Acad. Sci. USA*, **96**, 13611-13614, (**1999)**
4. Konishi Y. and Uruga T., Bioreductive Deposition of Platinum Nanoparticles on the Bacterium Shewanella algae, *J. Biotechnol*., **128**, **(2007):**648-653
5. Willner I., Baron R. and Willner B., Growing metal nanoparticles by enzymes, J. Adv. Mater, **18, (2006)**: 1109-1120,
6. Vigneshwaran N., Ashtaputre N.M., Varadarajan P.V, Nachane R.P., Paralikar K.M., Balasubramanya R.H., *Materials Letters*, **61(6), (2007)**1413-1418**.**
7. Shankar S.S., Ahmed A., Akkamwar B., Sastry M., Rai A Singh A. Biological synthesis of triangular gold., nanoprism, *Nature*, **3** 482, **(2004)**
8. Ahmad N., Sharma S., Singh V.N.,.Shamsi S.F, Fatma A. and Mehta B.R., Biosynthesis of silver nanoparticles from*Desmodiumtriflorum*: a novel approach towards weed utilization, *Biotechnol. Res. Int* .**454090** (1-8), **(2011)**

9. S. Cavalu; J. Prokisch; V. Laslo; S.Vicas " Preparation, structural characterisation and release study of novel hybrid microspheres entrapping nanoselenium, produced by green synthesis" IET Nanobiotechnology, **vol. 11**, (4), 2017, pp. 426 – 432.
10. C. Zhong; Z. Deng; R. Wang; Y. Bai,"Inhibition mechanism of calcium oxalate crystal growth by cooperation influence of colloidal selenium nanoparticles and bovine serum albumin"Cryst. Growth Des.,**vol. 15,** 2015, pp.1602–1610.
11. Chen Y, Liu C, Li F, Cheng H. "Preparation of single-crystal α-MnO2 nanorods and nanoneedles from aqueous solution". J Alloys Compd,(2005); 397: 282-285.
12. W. T. Nichols, T. Sasaki, N. Koshizaki, J. Appl. Phys. **100**, 114912 (2006)
13. Duntas, L.H., &Biondi, B. "The interconnections between obesity, thyroid function, and autoimmunity: the multifold role of leptin". Thyroid.,(2013): 23- 646.
14. Carmona, Y.V., Coria, M. J., Oliveros, L. B., &Gimenez, M. S. "Hypothyroidism and oxidative stress: differential effect on the heart of virgin and pregnant rats". Horm.Metab.Res. ,(2014) :46- 14.
15. Larsen, P. R., and Zavacki, A. M. " Role of the iodothyronine deiodinases in the physiology and pathophysiology of thyroid hormone action". Eur. Thyroid J. 1, (2012):232.
16. Adil Ban, H.,M. Al-Shammri Ahmed, and H. Murbat Hamid. "Cold Atmospheric Plasma generated by FE-DBD Scheme cytotoxicity against Breast Cancer cells."AIP Conference Proceedings 2190, 020033 (2019)
17. Op Soldin and M. Aschner. "Effcts of Manganese on Thyroid Hormone Homeostasis" Neurotoxicology. September 28(5) (2007): 951-956.
18. Choi J, Kim H, Kim P, kim HM, Iin SM, and Seoul" Toxicity of zinc oxide nanoparparticles in rats treated by two different routes: single intravenous iniection and single oral administration" J Toxicol Environ Heath A, 78(4), (2015):226-43.
19. Salitra G., Hodes G., Klein E., Tenne R." Highly oriented WSe2 thin films prepared by selenization of evaporated WO3". Thin solid films, **245**, (1994):180-185.
20. H Jamil., M. Khaleeq-ur-Rahman ., I M Dildar and Samia ., S. "Structural and optical properties of manganese oxide thin films deposited by pulsed laser deposition at different substrate temperature" Laser Phys., (2017) **27** :096101.
21. K .A .Aadim, A. Z. Mohammad and M. A .Abduljabbar "Influence of laser energy on synthesizes of CdO/Nps in liquid environment" Conf. Series: Materials Science and Engineering.**454** (2018): 012028.
22. olati E, Dejam L and Dorranian D" Effect of laser pulse energy and wavelength on the structure, morphology and optical properties of ZnO nanoparticles Opt". Laser Technol. vol. 58 (2014):26–32.
23. Z. Parang and D. Moghadamnia "Synthesis of Silver Nano-particles by Electrochemical Method and the Effects on the Serum Levels of Thyroid Hormones (T3, T4) in Adult Male Rats"Iranian Journal of Toxicology; **13** (4), (2019): 21-25.
24. S. Stefani and L. Halim1"Selenium in Hyperthyroidism" World.Nutr.Journal, (2019):2580-7013.
25. Yiyun Song, Xuan Yao, Hao Ying, "Thyroid hormone action in metabolic regulation",Protein Cell 2(5) (2011) : 358–368.
26. Xiao-Dong Zhang, Hong-Ying Wu, Di Wu, Yue-Ying Wang, Jian-Hui Chang, Zhi-Bin Zhai, Ai-Min Meng, Pei- Xun Liu, Liang-An Zhang, and Fei-YueFan"Toxicologic effects of gold nanoparticles in vivo by different administration routes"Int J Nanomedicine., ,(2010) 5: 771–781.

DOI: 10.37200/IJPR/V24I8/PR280462
Received: 21 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 14 Mar 2020