EGYPTIAN ACADEMIC JOURNAL OF

BIOLOGICAL SCIENCES

PHYSIOLOGY & MOLECULARBIOLOGY

C

ISSN
2090-0767

WWW.EAJBS.EG.NET

Vol. 15 No. 2 (2023)

.

Citation: *Egypt.Acad.J.Biolog.Sci. (C.Physiology and Molecular biology) Vol. 15(2) pp487-493 (2023)*
DOI: 10.21608/EAJBSC.2023.322407

Egypt. Acad. J. Biolog. Sci., 15(2):487-493 (2023)

Egyptian Academic Journal of Biological Sciences
C. Physiology & Molecular Biology
ISSN 2090-0767
www.eajbsc.journals.ekb.eg

Studying the Effect of AgNPs Silver Nanoparticles on The Spike Glycoprotein of SARS-CoV-2 Virus

Faesal G.Hassen and Amidah A. Atiyah
Pathological Analytics Department / College of Applied Sciences / Samarra University
***E-mail:** Ameeda.ali@uosamarra.edu.iq

ARTICLE INFO
Article History
Received:7/9/2023
Accepted:18/10/2023
Available:22/10/2023

Keywords:
Silver nanoparticles, spike protein, SARS-CoV-2

ABSTRACT

The chemically banned silver nanoparticles AgNPs were used, whose purity was tested by FESEM device using EDS, and the purity of AgNPs was 97.6. In addition to examining them by means of the dynamic atomic force microscope, which has the ability to take two- and three-dimensional images. For silver nanoparticles AgNPs, which showed sharp bumps up to a height of (15.3 nm) for the protein-coding of the SARS-CoV-2 virus and stopping the (RBD) region from binding to the receptors on the surface of the host cell within the spike protein. The results of the statistical analysis were in the study. The present study is that there is a significant increase between the different concentrations of silver nanoparticles on the outer protein coat, S protein, as it showed a high effect at a concentration of 50 at a rate of 12.23 ± 0.462pg/ml, while the lowest rate was recorded at a concentration of 0.3 at a rate of 0.16 ± 0.11pg/ml, mediated by the rest of the concentrations. In patients with SARS-CoV-2, at a rate of (11.40 ± 0.43, 11.00 ± 0.26, 0.16 ± 0.11, 4.53 ± 0.57, 9.06 ± 0.32, 9.80 ± 0.50, 10.63 ± 0.30), and according to concentrations (25, 12.5 , 6.25,3.12, 1.5, 0.75.).

INTRODUCTION

Nanoparticles are defined as solid particles with a size within the range of 10-100 nanometers (Mohanraj and Chen ,2006). Nanotechnology has made tremendous progress over the past decades, especially between 2005 and 2010, when its development has clearly increased and doubled over previous years , in the number of products that contain or require nanoparticles for their production. This development is supported by their unique overall properties in particular particle size, large surface area, higher chemical stability, surface reactivity, charge, and shape relative to their regular size counterparts (Manojkumar *et al.*, 2016).

Nanotechnology was developed as a new strategy in the field of antimicrobials to put an end to resistant microbes. Metal nanoparticles such as platinum, copper, silver and gold contain antimicrobials against bacteria that cause fungi and various diseases. In particular, silver nanoparticles have promising applications in nanotechnology and nanomedicine and have been approved for their bactericidal activity against bacterial infections as well as antiviral and antifungal effects on various pathogens (Rassin *et al.*,2015). Among metal nanoparticles, silver nanoparticles have been in use since the 1880s because silver has broad-spectrum antimicrobial activity against a wide range of microorganisms. The small size (1–100 nm) allows AgNPs to interact with a similarly sized biological target, as they can pass through a barrier. The model plasma membrane, which shows excellent performance in many aspects, especially its virucidal activity (Sun *et al.*,2020).

Citation: *Egypt.Acad.J.Biolog.Sci. (C.Physiology and Molecular biology) Vol. 15(2) pp487-493 (2023)*
DOI: 10.21608/EAJBSC.2023.322407

AgNPs are widely applied in contemporary medicine. Their bactericidal effect prompted researchers in the field of viricides to evaluate whether these particles also have a virucidal effect. AgNPs are known for their high antimicrobial activity, biocompatibility, and low toxicity in eukaryotic cells. (Das*etal*.,2020). AgNPs can effectively inhibit RNA and DNA viruses such as HIV and respiratory viruses. The medicinal properties of silver were recognized very early in the history of civilization in Europe during the Middle Ages. Compounds containing silver were explicitly registered as medicines in Roman pharmacopoeia since the Tang Dynasty in China where silver was used to treat acne diseases caused by viruses in early China, these ancient records confirm the potential of silver nanomaterials in the field of viruses (Jeremiah *et al*.,2020). Studies have shown that AgNPs mainly exert their virus-killing effect through two mechanisms. The first mechanism aims to prevent the virus from infecting the host cell, and this effect can be achieved through the combination of sulfur-containing residues on the surface of the glycoprotein. It was found that by binding to the viral glycoprotein it can be AgNPs prevent RSV from entering host cells. In the second mechanism, AgNPs enter the host cell and then block the mechanism necessary for viral assembly (Nouri *et al*.,2015).

MATERIALS AND METHODS

Sample collection The study included patients who had a confirmed diagnosis of the virus through the positive result of the reverse transcription polymerase chain reaction (RT-PCR) test through a swab taken from the nasopharynx of the upper respiratory tract and who were suffering from symptoms of infection with the virus. Blood samples were collected from Samarra Hospital General and external laboratories in the judiciary of Covid patients.

Methods For Preparing Silver Nanoparticles:

There are multiple methods for preparing silver AgNPs nanoparticles, such as chemical, physical, photochemical, and biological. Each method has its advantages and disadvantages (Merga, *et al.,* 2007).

Chemical Methods:

The most common method for the synthesis of nitrogenous silver is chemical reduction by organic and inorganic reducing agents. Generally, various reducing agents such as sodium citrate, ascorbate, sodium borohydride (NaBH4) elemental hydrogen, polyol process, Tollens reagent, N,N-dimethylformamide (DMF), and poly(ethylene glycol)-copolymers are used for reducing of silver ions (Ag+) in aqueous or non-aqueous solutions. These reducing agents reduce Ag+ and lead to the formation of metallic silver (Ag0), which is followed by agglomeration into oligomeric clusters. These groups eventually lead to the formation of metallic colloidal silver particles (Merga *et al*.,2007).

The Way To Prepare The Mixture:

The dilutions were prepared by dissolving 1 gram of silver nanoparticles AgNPs in 10 ml of DMSO liquid so that the concentration became 100 mg / ml prepared in stock form, where each 1 gm represents 1000 mg, and by dividing the weight by the volume, the prepared solution was obtained. 7 dilutions were prepared by taking 5 ml of the prepared solution and adding 5 ml of distilled water to make the concentration 50 mg / ml, then we take 5 ml of the concentration 50 mg / ml and add 5 ml of distilled water to it so that the concentration becomes 25 mg / ml and so on for the rest of the concentrations and according to what is shown in the Table 1.

Table 1: Dilutions prepared from silver nanoparticles AgNPs.

Sequencing	The Tube	AgNPsmg/ml concentration
1	First tube	50
2	Second tube	25
3	Third tube	12.5
4	Fourth tube	6.25
5	Fifth tube	3.12
6	Sixth tube	1.5
7	Seventh tube	0.75
8	Eight tube	0.3

RESULTS AND DISCUSSION

In this study, chemically banned silver particles were used, whose purity was tested by a dynamic atomic force microscope, which has the ability to take two- and three-dimensional images of silver nanoparticles (AgNPs), which showed sharp bumps up to (15.3nm) in height, as shown in the Figures (1 and 2), which depends on measuring the force between the wiper and the surface of the sample, as the results showed the presence of silver nanoparticles in a spherical shape or in the form of a triangular structure, as shown in Figure (2). The size of the AgNPs silver nanoparticles was also measured, and the results showed that the size of the particles was small The size of 76nm and small amounts of it were medium, as shown in Table (2) and shown in Figure (3), which shows that the percentage of small particles was high. This study is similar to a study conducted by (Hussein *et al*.,2015). It is also similar to what Korbekandi and others 2012 concluded, which showed the biologically synthesized silver nanoparticles were semi-spherical, individually with a size of (25-50 nm) and in other aggregates with a size of (100 nm).

Table 2: Shows the size of silver nanoparticles AgNPs measured in nanometers by the AFM device.

AgNPs	projected area	Area with nm2	Area with nm
Nano1	small	8652	80.18
Nano2	small	16143	124.4
Nano3	small	2797	46.96
Nano4	middle	40090	206.9
Nano5	small	18746	135.1
Nano6	small	1582	24.93
Average		9922	76.00

After examining the AgNPs silver nanoparticles with the AFM device, their purity was tested by the FESEM device, as the FESEM image showed good dispersion of AgNPs and the spherical shape of the nanoparticles with a particle size distribution of 55 nanometers, as shown in Figure (4). The study of the surface topography and these results are consistent with what was reached by (Santos *etal*.,2020) FESEM showed the formation of AgNPs in a spherical and triangular shape and within a size of 55 nm)) which is also consistent with the results of AFM that showed the presence of silver nanoparticles in a spherical and triangular shape and as shown in the Figure (2).

A test of silver nanoparticles was carried out on the viral thorn protein of the SARS-Covid-2 virus using different concentrations of silver nanoparticles. At a concentration of 50, at a rate of 12.23 ± 0.462, while the lowest rate was recorded at a concentration of 0.03 at a rate of 0.16 ± 0.11, as shown in Figure (5-1), mediated by the rest of the concentrations in SARS-COV-2 patients (P. Valeu ≤ 0.05) and at a rate of (11.40 ± 0.43 11.00). ± 0.26, 0.16 ± 0.11, 4.53 ± 0.57, 9.06 ± 0.32, 9.80 ± 0.50, 10.63 ± 0.30) and according to concentrations (25, 12.5, 6.25, 3.12 , 1.5, 0.75), as shown in Table (3).

Table 3: Shows the effect of different concentrations of silver nanoparticles on the spike protein coating.

AgNPs con	Mean	Signal
50	12.23±0.462	A
25	11.40 ±0.43	B
12.5	11.00 ±0.26	C
6.25	10.63 ±0.30	D
3.12	9.80 ±0.50	E
1.5	9.06±0.32	F
0.75	4.53±0.30	G
0.3	0.16±0.22	H
LSD≤ 0.05	**0.398**	

Where the uppercase letters indicate a significant difference P ≤ 0.05, while the small letters indicate that there is no significant difference P ≥ 0.05.

The S protein is the most important among them because it causes rapid proliferation in the host body, where the glycine and alanine components of HR1 of the S protein are the ideal targets for antiviral action, as is the case for silver nanoparticles. Together with other proteins, AgNPs therefore, possess strong antiviral activity, as silver nanoparticles AgNPs inhibit the furin enzyme present in the S protein, thus stopping the penetration of SARS-CoV-2 into the host cell and preventing the entry of the viral genome responsible for the S2 subunit when the virus approaches the host cell membrane Two regions of S2 are repeated (HR1, HR2), and thus AgNPs work to stop (RBD) by binding with it and preventing it from binding to the ACEE2 receptor on the surface of host cells (Duran*etal.*,2015). Hence AgNPs bind to the viral genome and thus inhibit the activity and interaction of different viral and cellular factors responsible for replication leading to inhibition of virus replication and release of progeny viruses (Saleh*etal.*,2020). Moreover, the interaction of AgNPs with viruses can be enhanced by different physicochemical properties such as Size, shape, surface charge, and dispersion. All these properties have therapeutic significance for silver nanoparticles and their ability to penetrate the spike protein. AgNPs considered one of the potential therapeutic nanoparticles and are included in most commercial NPs considering their distinctive catalytic, photothermal, and clinical applications. Silver AgNPs nanoparticles respond to the immune system and cause inflammatory apoptosis in the host (Chacón *et al.*,2020).

The proteins encoding SARS-CoV-2 are important molecular targets of antivirals due to their essential roles in the viral life cycle. Entry of SARS-CoV-2 is mediated by binding of the viral spike protein (S) to the host cell receptor, angiotensin-converting enzyme ACE2(Hussain *et al.*,2018), 2020. After entry, the SARS-CoV-2 viral is translated by the host to produce multiple proteins from two overlapping reading frames (ORF1a and ORF1b). The multiple proteins are then cleaved using various nanoparticles in combination with molecular biology of interest. Recently, through the use of some nanocarriers for delivery, such as drug delivery or anti-SARS-Cov-2 vaccines, nanoparticles can be used to fight the virus directly, while others are used for rapid detection of viruses (Wang *et al.*,2022).

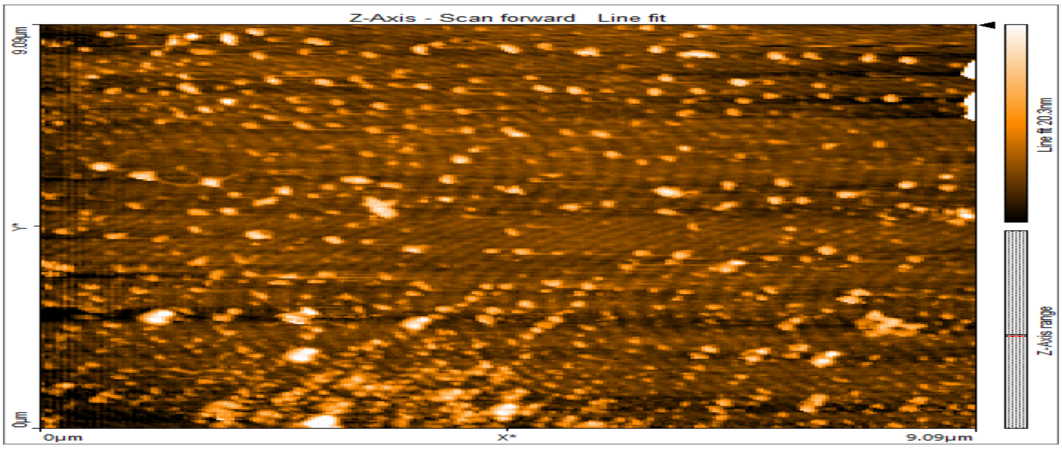

Fig. 1: Shows AgNPs using dynamic atomic force microscopy (AFM).

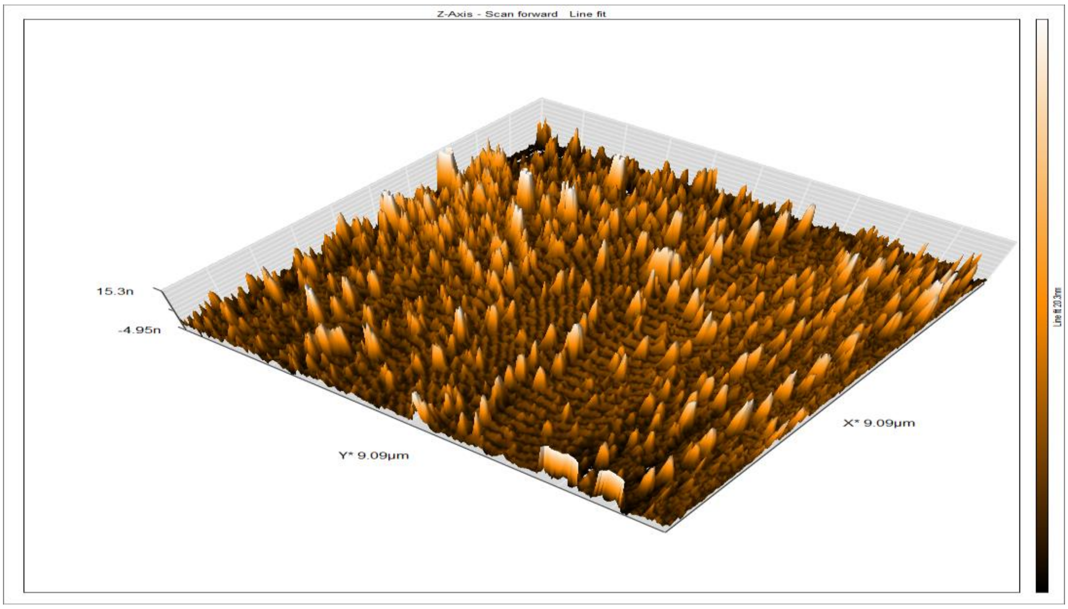

Fig. 2: A three-dimensional image taken for the x- and y-axes of the AFM device, showing the high prominences of AgNPs, which are 15.3nm.

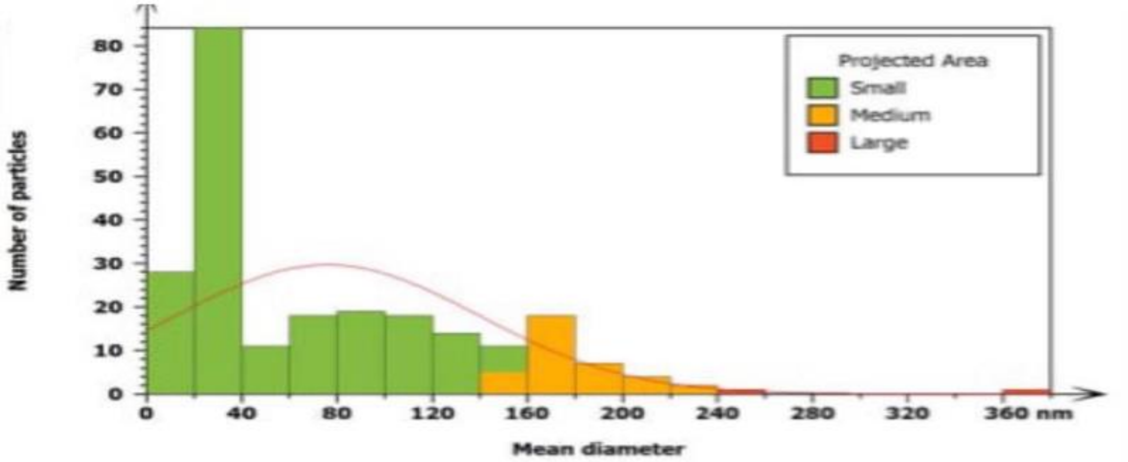

Fig.3:A Graph of AgNPs silver nanoparticles showing the size of the particles used in the current study.

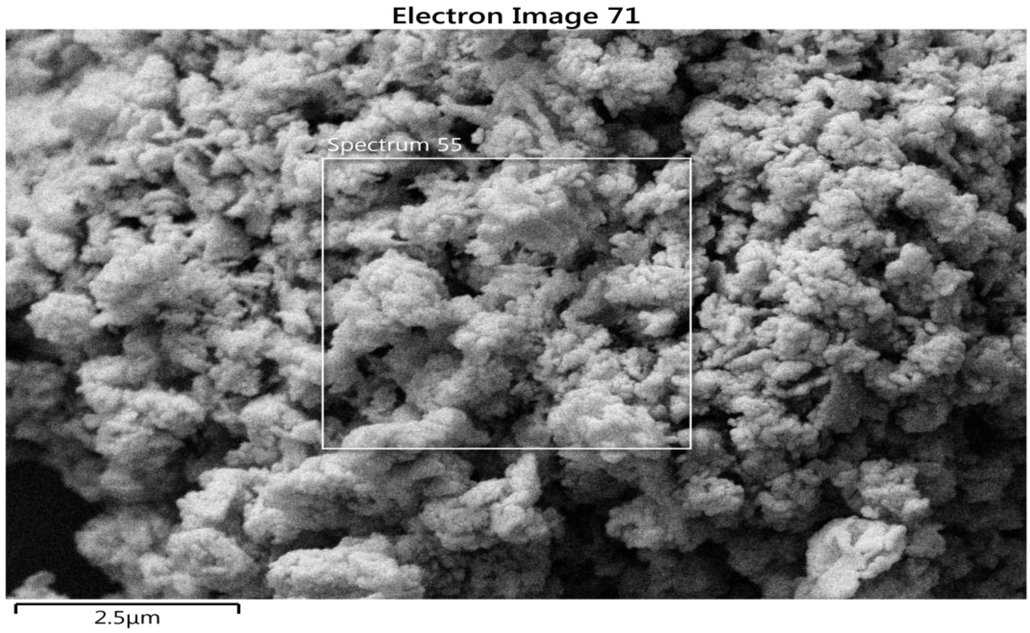

Fig. 4: shows silver nanoparticles and AgNPs using the FESEM device**.**

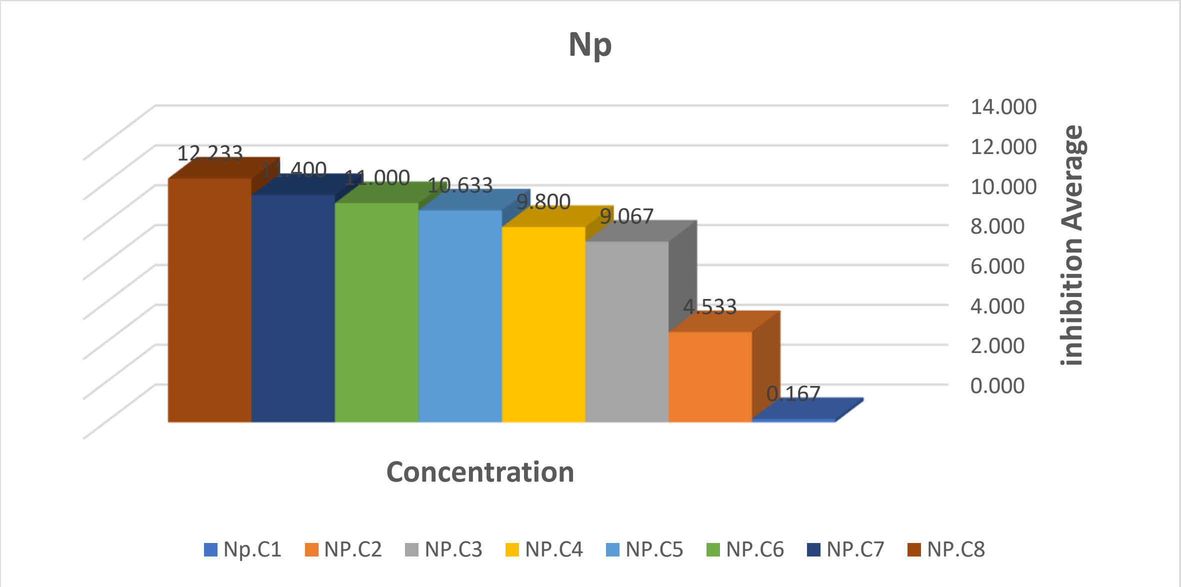

Fig. 5: Shows the effect of different concentrations of silver nanoparticles AgNPs on the spike protein of SARS-COV-2**.**

REFERENCES

Chacón - Torres , J.C.; Reinoso, C.; Navas-León, D.G.; Briceño, S.; González, G. (2020). Optimized and scalable synthesis of magnetic nanoparticles for RNA extraction in response to developing countries' needs in the detection and control of SARS-CoV-2. *Scientific Reports*, 2020, 10, 1–10. [CrossRef] [PubMed]

Das, C. , Paul, S. S. , Saha, A. , Singh, T. , Saha, A. , Im, J. , & Biswas, G. (2020). Silver-based nanomaterials as therapeutic agents against coronaviruses: A review. *International Journal of Nanomedicine*, 15, 9301–9315.

Duran, N. , Silveira, C. P. , Durán, M. , & Martinez, D. S. T. (2015). Silver nanoparticle protein corona and toxicity: A mini-review. *Journal of Nanobiotechnology*, 13(1), 55. 10. 1186/s12951-015-0114-4

Jeremiah S.S., Miyakawa K., Morita T.,

Yamaoka Y., Ryo A.(2020). Potent antiviral effect of silver nanoparticles on SARS- CoV 2. *Biochemical and Biophysical Research Communications* 533: 195–200.

Hussein, H.S., Dheeb B.I., Hamada,T.A.. (2019). Studying the candida resistance and sensitivity for some antifungals *Journal of Biotechnology Research Center*, 13 (2)25-34.

Hussain, A.F., Sulaiman, G.M., Dheeb, B.I. , Hashim, A.J., (2018). Histopathological changes and expression of transforming growth factor beta (TGF-β3) in mice exposed to gliotoxin. *Journal of King Saud university Science*, 27, 193–197.12.

Manojkumar, K., Sivaramakrishna, A., & Vijayakrishna, K. (2016). A short review on stable metal nanoparticles using ionic liquids, supported ionic liquids, and poly (ionic liquids). *Journal of Nanoparticle Research*, 18(4), 103.

Merga,G.Wilson,R.Lynn,Geoffry.Milosavljevic,B,H.&Meisel.D.(2007). Redox Catalysis on “Naked” Silver Nanoparticles. *Journal of Phyical. Chemistry. C* , 111, 33, 12220–12226

Mohanraj,V.I and Chen.Y .(2006).Chitosan-Based Nanoparticles for Delivery of Proteins and Peptides. *Tropical Journal of Pharmaceutical Research* Vol. 5 (1) pp. 561-573.

Nouri, M. A., Al-Halbosiy, M. M. F., Dheeb, B. I. and Hashim, A. J. (2015). Cytotoxicity and genotoxicity of gliotoxin on human lymphocytes in vitro. *Journal of King saud university Science*, 27, 193–197.

Rassin, N. K., Nemat J. A, Dheeb, B. I.. (2015). Molecular Identification of Aspergillus fumigatus Using ISSR and RAPD Markers. *Iraqi Journal of Science*, 56 (4A), 2788-2797.

Saleh. m . James, G .David. C. Beom , S . Amtul , M.Eitezaz ,M. *et. al.(*2020). Effect of chloroquine, hydroxychloroquine , and azithromycin on the corrected QT interval in patients with SARS-CoV-2 infection. *Circulation: Arrhythmia and Electrophysiology*, Vol,13:No.6.

Santos H,F, Dos Santose C,G. Nasimento OR, ReisA,KCA, Lanfirde A.J.C, DE Olivera H.P.M & Nantes-cardoso I,L (2020). Charge separation of photosensitized phenothiazines for applications in catalysis and nanotechnology. *Dye Pigment*, 177: 108314.

Sun, J., He, W.-T., Wang, L., Lai, A., Ji, X., Zhai, X., Li, G., Suchard, M. A., Tian, J., & Zhou, J. (2020). COVID-19: epidemiology, evolution, and cross-disciplinary perspectives. *Trends in Molecular Medicine*, 26(5), 483–495.

Van Dong, P., Ha, C. H., & Kasbohm, J. (2012). Chemical synthesis and antibacterial activity of novel-shaped silver nanoparticles. *International Nano Letters*, 2(1), 9.

Wang, J.; Drelich, A.J.; Hopkins, C.M.; Mecozzi, S.; Li, L.; Kwon, G.; Hong, S.(2022) Gold nanoparticles in virus detection: Recent advances and potential considerations for SARS-CoV-2 testing development. Wiley Interdiscip. *Reviews: Nanomedicine and Nanobiotechnology*, 14, e1754.