COMBINATION OF CIPROFLOXACIN AND SILVER NANOPARTICLES FOR TREATMENT OF MULTI-DRUG RESISTANT *PSEUDOMONAS AERUGINOSA* IN EGYPT

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Abstract

Pseudomonas aeruginosa was the most frightening pathogen that emergence in health facilities with increasing antibiotic resistance. Nanoparticles have reported as non-antibiotic therapeutic agents, that are highly effective in the treatment of *P. aeruginosa* infections. Combination therapy of nanoparticles and antibiotics considered an alternative therapeutic approach for restoring antibiotic activity. To achieve that goal, we used the synthetic silver nanoparticles in a combined form with ciprofloxacin against MDR *P. aeruginosa*. Fifty bacterial isolates that collected from different infection sites were confirmed as *P. aeruginosa* by detection of algD gene and Exotoxin A genes. Antibiotic sensitivity of *P. aeruginosa* strains was assessed by single disk-diffusion method. The most prevelant phenotype among *P. aeruginosa* were recorded. The synthetic nanoparticles AgNPs and ZnONPs were tested against all *P. aeruginosa* strains. minimum inhibitory conc (MIC) of ciprofloxacin and AgNPS was determined using microdilution method for 24 selected *P. aeruginosa* strains and in the range from 160-1280, 6-12mg/l, respectively. *In vitro*, the synergistic activity of ciprofloxacin and AgNPs was achieved in all combinations. Our finding approved that combination therapy depend on using nanoparticles considered a promising tool used to restore the activity of antibiotics.

Keywords*: Pseudomonas aeruginosa*, nanoparticle, ciprofloxacin, antibiotic sensitivity, minimum inhibitory concentration

Introduction

Pseudomonas aeruginosa is a dangerous opportunistic nosocomial pathogen. *P. aeruginosa* infections are common in hospitalized patients. it can be occurred in many anatomic sites like urinary tract, skin, ears, heart valves, bones, eyes, and subcutaneous tissue of serious infection as urinary tract infection, pneumonia, eye infection (keratitis), otitis, skin infection (folliculitis), septicemia, osteomyelitis, respiratory infection and wound infection especially patient with burn wounds. (Murry *et al.,* 2002 and Hoge *et al*., 2010)

P. aeruginosa is a Gram-negative, straight or slightly curved rod-shaped, non-

spore forming bacteria with high mortality and morbidity rates in humans. (Gabra *et al*., 2012). *P. aeruginosa* is widely distributed in nature present in soil, water, various types of vegetation throughout the world, respiratory equipment, disinfectants, sinks, taps, and mops in the hospitals (Murray *et al.*, 2002 and Todar, 2011).

Excessive use of antibiotics accelerates the development of multidrug-resistant *P. aeruginosa* isolates, which lead to the ineffectiveness of the antibiotic therapy. (Hirsch and Tam, 2010). *P. aeruginosa* has resistance to many antibiotics that already used like aminoglycosides, quinolones, and β-lactams. (Hancock & Speert, 2000 and Lister *et al.*, 2009).), so the development of new antibiotics or alternative therapy for the treatment of *P. aeruginosa* infections is needed for patients who have infections resistant to conventional antibiotics.

Chatterjee *et al.*, (2016) have reported several non-antibiotic therapeutic, which is highly effective in the treatment of *P. aeruginosa* infections. These approaches include phage therapy, inhibition of quorum sensing and bacterial lectins, use of iron chelation, nanoparticles, antimicrobial peptides, electrochemical scaffolds, and vaccine strategy. These therapeutic approaches can be used instead of antibiotics or in combination with antibiotics .

Nanoparticles of heavy metals as metal oxides have a high ability to interact with pathogenic microorganisms and deactivate or eliminate the virus or bacteria especially *P. aeruginosa* (Salehi *et al*, 2013; and Chauhan *et al.*, 2014). Effectiveness of nanoparticles as antimicrobial agents was due to small doses used, low toxicity and lack of side effects (Lara *et al*., 2010) and its bactericidal activity depends on their concentration, their stability, and size of nanoparticles (Raghupathi *et al.*, 2011).

Traditionally silver nanoparticles AgNPs have a strong antibacterial activity, medical and technological applications (Edwards-Jones, 2009). Many studies proposed a different antibacterial mechanism of AgNPs synthesized using different methods, Singh *et al*., (2008) proposed that the production of reactive oxygen species that damage bacterial cell membranes.While; Rai *et al.*, (2009) demonstrated the interaction of AgNPs with sulfur-containing membrane proteins.

On the other hand, Sawai, (2003) found that ZnO NPs have a strong antibacterial activity illustrated by direct contact of ZnO-NPs with cell walls of bacteria and destruction of the cell wall with the liberation of Zn+2 ions. There are several mechanisms of antibacterial activity of ZnO NPs including:

1) The induction of reactive oxygen including hydrogen peroxide [H2O2].

2) The destruction of cell membranes and the interaction of ZnO NPs with intracellular components of the cell. In general, cell membrane of bacteria has pores in nanometer which facilitate the entrance of ZnO NPs through these pores (Li *et al*., 2011).

The aim of this study was to the impact of silver and zinc nanoparticles as an alternative therapeutic strategy in combination with ciprofloxacin antibiotics on multi-drug resistance *Pseudomonas aeruginosa* clinical strains.

Material and Methods:

Study design

Fifty clinical bacterial isolates were collected from the New Kasr El-Ainy teaching hospital. Fifty consecutive *P. aeruginosa* isolates from clinically significant infections sites were collected including pus specimens, blood cultures, pleural fluid, urine, ascitic fluid, sputum, and Central Venous Line. The study was conducted from (January 2015 - January 2016). Identification to the genus level was done by a traditional microbiological method and it was confirmed by algD gene detection and Exotoxin A (ETA) using the sequences of the primers in Table 1.

Table 1: Primers used in this study

Gene name	Use		Sequence (5'-3')	Bp	Refrence
algD gene	*Pseudomans aeruginosa* Identification	F	5 -'TTCCCTCGCAGAGAAAA-CATC -3	520	Da Silva *et al.*, 1999
		R	5-CCTGGTTGATCAGGTC-GATCT -3		
Exotoxin A		F	5-GACAACGCCCTCAGCATCACCAGC-3	396	Al-Daraghi and Husamuldeen 2013
		R	5-CGCTGGCCCATTCGCTCCAGCGCT-3		

Condition of the PCR :

the reaction mixtures were subjected to Biometra UNO-thermoblock cycler using the following program:

Cycle step	Temperature	Time	Number of cycles
initial denaturation	94C	5 min	1
denaturation	94C	1 min	30
annealing	60C	1 min	30
extension	72C	1 min	30
final extension	72C	7 min	1

Antibiotics susceptibility test:

Antibiotics susceptibility test was determined for *P. aeruginosa* strains (1.5×10 ˆ8) CFU/ml using standard disc diffusion method (Bauer *et al.*, 1966) and according to the recommendation of CLSI document M02-A12 (CLSI 2015) in Cation-adjusted Mueller-Hinton agar (CA-MHA) (Oxoid, UK). All fifty clinical *P. aeruginosa* strains were tested for resistance to 14 commercially antibiotic discs; imipenem (10 µg), meropenem (10 µg), cefotaxime (30 µg), cefturoxime (30 µg), ciprofloxacin (5 µg), ceftriaxone (30 µg), colistin (10 µg), polymyxin (300 u), amikacin (30 µg), levofloxacin

(5 µg), ceftazidime (30 µg), gentamicin (10 µg), ampicillin-sulbactam (10/10µg), amoxicillin/clavulanic acid (10/10µg) that selected according to CLSI guidelines . The standard strains of *P. aeruginosa* ATCC 15442 and *E. coli* ATCC 25922 were used to confirm the results.

Nanoparticles synthesis:

Silver nanoparticles (AgNPs) and Zinc oxid nanoparticles (ZnO NPs) were synthesized and prepared in Nano-Tech Egypt Company according to Pacholski *et al.,* (2002) ; Beek *et al,*. (2005) and Pal *et al.,* (2009).

Determination of Minimum Inhibitory Concentrations (MICs)

MIC of ciprofloxacin (Sigma-Aldrich), Silver nanoparticles and Zinc oxide nanoparticles for 24 clinical selected MDR *P.aeruginosa* strains (1.5×10 ˆ5 CFU/ml) determined by broth microdilution method in Cation-adjusted Muller Hinton Broth (CA-MHB) (Oxoid, USA) according to (EUCAST, 2000) and (CLSI 2015). MIC was performed in 96-well microtitre plates. CA-MHB containing serial of two-fold dilutions of ciprofloxacin, silver nanoparticles (3 - 200 mg/l), and zinc oxide nanoparticles (7.8-2000 mg/l) were prepared.

Combination of ciprofloxacin antibiotic with silver nanoparticles against *Pseudomans aeruginosa* clinical strains by using Checkerboard method:

The dynamic checkerboard method was performed to evaluate the interaction of silver nanoparticles and zinc oxide nanoparticles in combination with ciprofloxacin (Bajaksouzian *et al*., 1997; Mackay *et al*., 2000 and Petersen *et al*., 2006) against 24 selected clinical *P. aeruginosa* strains. Organisms, antibiotic, and nanoparticles concentrations were prepared as described for the MIC determination using microtitre plates. To evaluate the effect of the combination the fractional inhibitory concentration (FIC) index was calculated for antibiotic and nanoparticles using the following formula:

$$\textbf{FIC index} = \textbf{FIC}_A + \textbf{FIC}_B$$

$\textbf{FIC}_A$ = MIC of drug A in combination/MIC of drug A alone

$\textbf{FIC}_B$ = MIC of drug B in combination/MIC of drug B alone

The FIC indices were interpreted as:

Synergy (of the joint action of two antimicrobial agents that when tacked together to increase each other effectiveness) = **FIC** ≤ 0.5

Additive or indifferent (no interaction means that an effect in which two antimicrobial agents produce a total effect the same as the sum of the individual effects) = FIC $>0.5 \leq 4.0$

Antagonism (Opposition of action; counteraction or contrariety action**)** = FIC > 4.0.

After determining the MIC of silver NPs and antibiotic alone and together in combination, the percentage of growth inhibition for *P. aeruginosa* in comparison with positive control was calculated using the following equation (Bayroodi and Jalal, 2016)

GI%=100-OD at the presence of antibacterial agent/OD of positive control×100

The statistical method:

The results of the percentage of growth inhibition of ciprofloxacin and silver nanoparticlles alone and in combination together are expressed as mean± standard error means (SEM). Every experiment was repeated three times. All data were analyzed and

compared utilizing one-way ANOVA Duncan test 1995 by using SAS 2004 v.9 and differences with $p < 0.05$ were considered significant (Duncan, 1955, SAS, 2004).

Results

A total of Fafity bacterial isolates were collected from the microbiology laboratory in Al-Kasr Al-Ainy Hospitals from January 2015 to January 2016. The number of collected isolates were distributed according to infection sites (Fig. 1). *P. aeruginosa* strains were predominating in pus culture followed by sputum and urine culture, however, blood culture , central venous line, Ascetic fluid and Pleural fluid were recorded as lowest infection sites for *P. aeruginosa*.

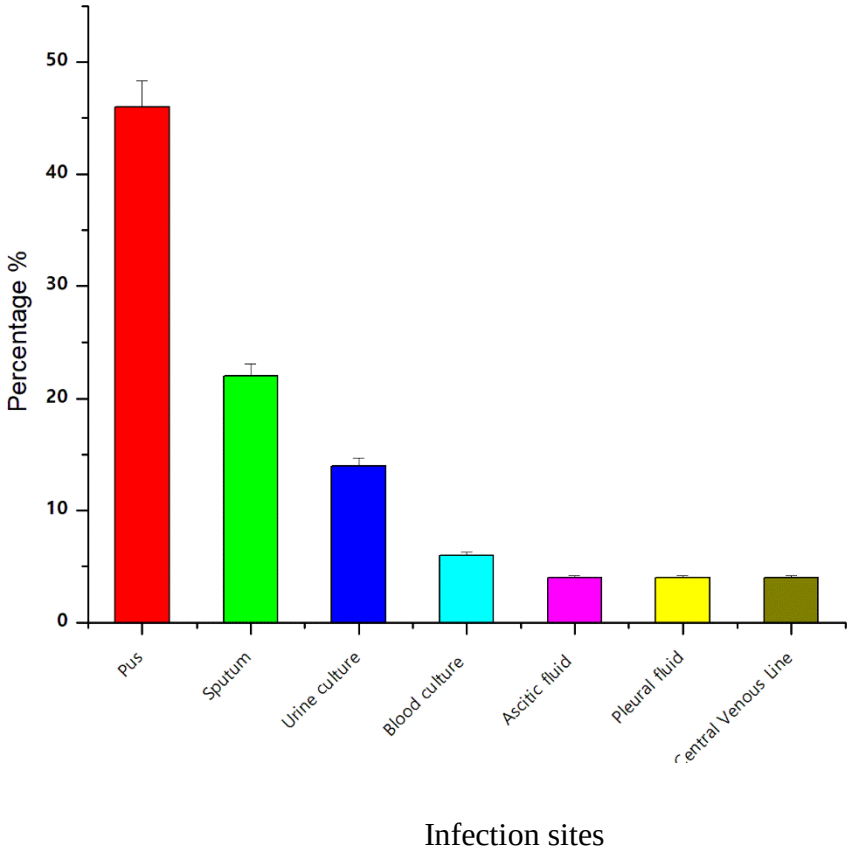


Figure. 1. Prevalence of *P. aeruginosa* according to infection sites

Molecular identification of clinical *Pseudomonas aeruginosa* using Polymerase Chain Reaction (PCR):

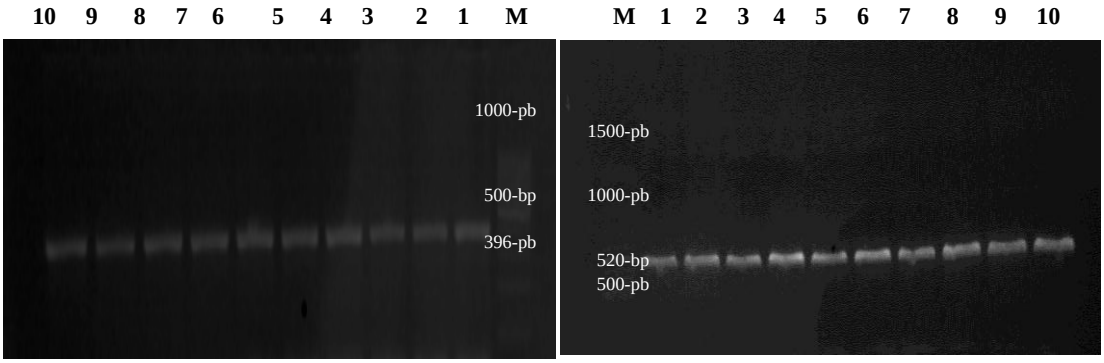
Fifty clinical bacterial isolates that primarily identified as *Pseudomonas* genus were further confirmed as *Pseudomonas aeruginosa* using molecular detection of *algD* GDP mannose and *exotoxin A* genes that is characteristic for *P. aeruginosa* using conventional PCR technique at amplification size 520 bp and 396 bp, respectively (Fig.2)

Nanoparticles synthesis

Ag and Zn nanoparticles were synthesized with average size 19 ± 2 nm and average size 20 ± 5 nm, respectively. AgNPs and ZnO NPs have spherical shape (Fig.3).

Antibiotic susceptibility test:

P. aeruginosa strains were recorded as resistance to three or more antibiotics. These degrees of resistance was confirmed to all clinical *P. aeruginosa* strains as following, *P. aeruginosa* was resistance to β-lactam, aminoglycosides, and fluoroquinolones, and no resistance showed to colistin. The high resistance rate in strains was recorded against ceftazidime (CAZ) 96%, cefotaxime (CTX) 92%, while the resistance rate exceeds 40% for both Ciprofloxacin (CIP) and Levofloxacin (LEV) (48%). On the other hand, Colistin (CT) showed a higher inhibitory effect (100%) against 50 clinical *P. aeruginosa* strains while Polymyxin (PB) recorded 98% inhibitory effect against 49 *P. aeruginosa* strains. Based on antimicrobial susceptibility test, twenty-four MDR *P. aeruginosa* resistant to ciprofloxacin subsequently was selected for further study. (Figure. 4).



(figure.2-A) **(figure.2-B)**

Figure 2. Agarose gel electrophoresis of Exotoxin A at 360 pb (figure.2-A) and algD gene at 520-bp PCR products(figure.2-B). M: Marker, Lane 1-10 positive *P. aeruginosa* strains

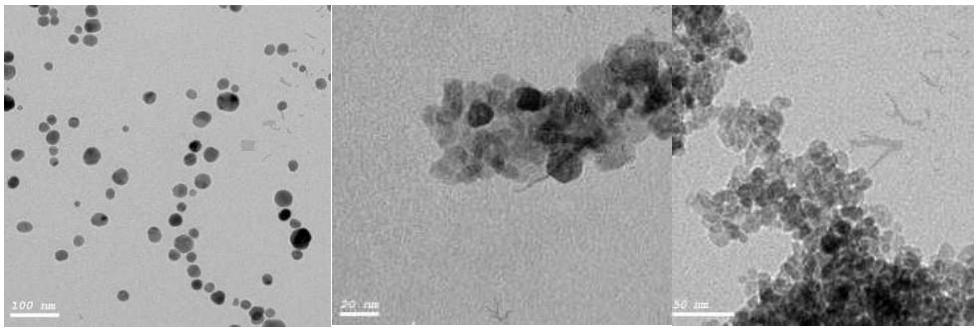


Figure.3 HRTEM of spherical silverand zinc nanoparticles

Determination of minimal inhibitory concentration (MIC) of Ciprofloxacin and Silver nanoparticles against selected clinical *P. aeruginosa* strains:

Our data clarify that the highest inhibition for growth by ciprofloxacin was significantly ($p < 0.05$) achived for twelve *P. aeruginosa* strains (more than 99%), ten strains were significantly inhibited at 320 mg/l and two inhibited at 1280 mg/l. However, the highest inhibition for growth by silver nanoparticles was recorded for

eight *P. aeruginosa* strains at 12 mg/l (98-99%) (Table 1). On the other hand, our results represented that zinc oxide nanoparticles have no effect on 24 clinical *P. aeruginosa* strains, even with increasing the ZnO NPs concentration until 2000 mg/l.

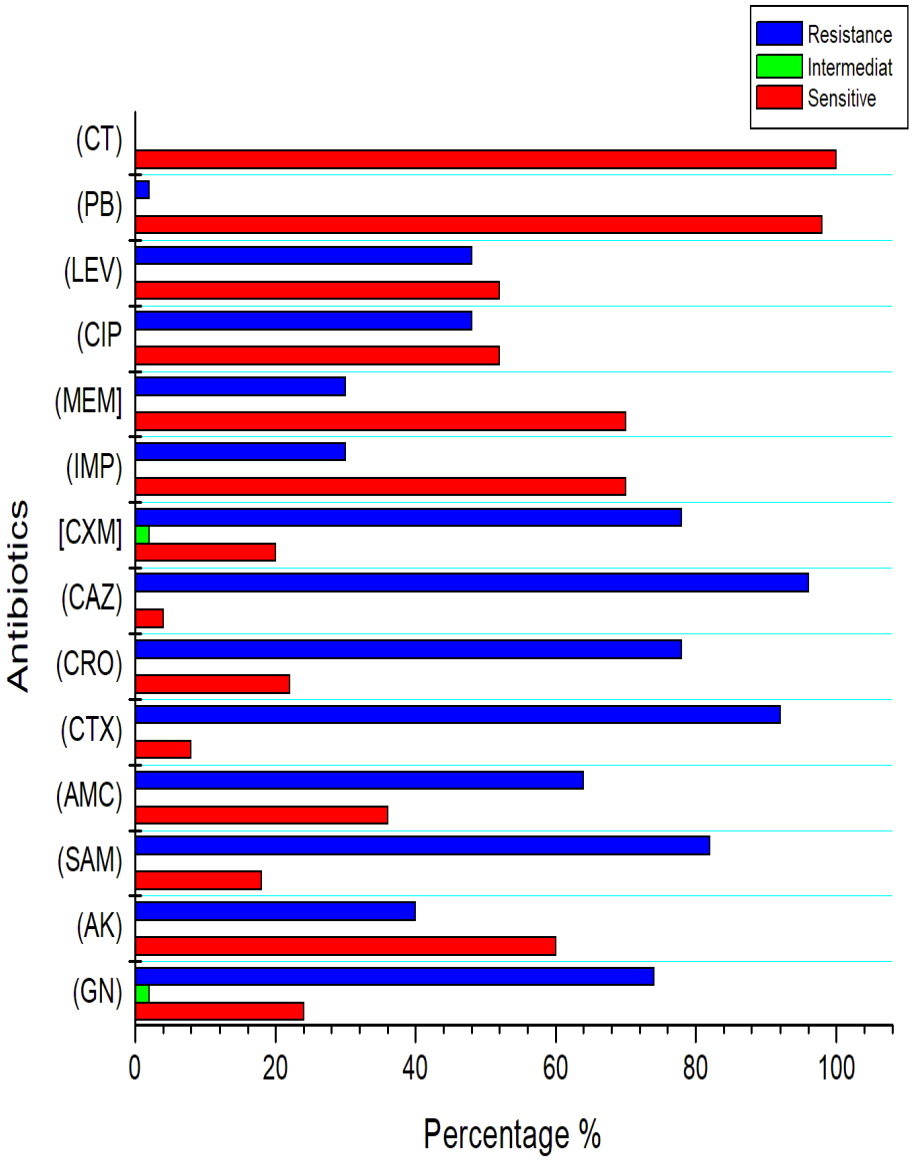


Figure. 4. Sensitivity index of clinical *P. aeruginosa* strains

Combination of ciprofloxacin antibiotic with silver nanoparticles:

A combination of ciprofloxacin and silver nanoparticles considered a promising approach, synergistic action was achieved according to FIC index in all combinations used. Our results showed the activity of ciprofloxacin was increased in the presence of Ag-NPs against the tested strains. Table 2 summries the decreasing in the concentration of ciprofloxacin with 2 fold change for the majority of the *P. aeruginosa* strains and 3 fold change for only 6 *P. aeruginosa* strains. For silver nanoparticles concentration, the fold change was 2 for all *P. aeruginosa* strains.

Table (1): Determination of minimal inhibitory concentration (MIC) of ciprofloxacin and Silver nanoparticles against selected clinical *P. aeruginosa* strains:

P. aeruginosa strains	MIC of ciprofloxacin mg/l	Growth inhibition %	MIC of silver nanoparticles mg/l	Growth inhibition %
GH 1	320	99.56	6	96.5
GH 4	160	98.56	6	97.49
GH 5	1280	99.22	12	99.11
GH 6	1280	98.27	12	99.37
GH 8	160	97.19	6	96.2
GH 9	320	99.6	6	97.4
GH 10	1280	98.44	12	98.96
GH 12	160	96.66	12	99.14
GH 15	160	96.96	6	98.52
GH 16	1280	97.79	12	99.37
GH 17	320	99.46	6	97.11
GH 19	1280	99.5	12	99.38
GH 20	160	96.3	6	97.76
GH 23	320	99.31	6	96.51
GH 28	320	99.25	6	97.2
GH 31	320	99.19	12	99.35
GH 32	160	97.54	12	99.52
GH 35	320	99.42	6	97.44
GH 38	160	98.01	6	97.53
GH 41	320	99.44	6	97.6
GH 42	1280	96.43	12	99.45
GH 46	160	96.66	6	98.02
GH 49	320	99.33	6	96.58
GH 50	320	99.56	6	97.96

Table (2) Fractional inhibitory concentration index (FICI) of the combination between ciprofloxacin and silver nanoparticles against selected *P. aeruginosa* strains using checkerboard method (synergy action).

***P.aeruginosa* strains**	**MIC of ciprofloxacin mg/l**	**MIC of silver nanoparticles**	**MIC combination of ciprofloxacin/ silver nanoparticles**	**Fraction Inhibitory Concentration Index (FICI)**	**Fold decrease in CIP/Ag NPs**	**Activity**
GH 1	320	6	80/1.5	0.5	2/2	Synergy
GH 4	160	6	40/1.5	0.5	2/2	Synergy
GH 5	1280	12	320/3	0.5	2/2	Synergy
GH 6	1280	12	320/3	0.5	2/2	Synergy
GH 8	160	6	40/1.5	0.5	2/2	Synergy
GH 9	320	6	40/1.5	0.37	3/2	Synergy
GH 10	1280	12	320/3	0.5	2/2	Synergy
GH 12	160	12	20/3	0.37	3/2	Synergy
GH 15	160	6	40/1.5	0.5	2/2	Synergy
GH 16	1280	12	320/3	0.5	2/2	Synergy
GH 17	320	6	80/1.5	0.5	2/2	Synergy
GH 19	1280	12	320/3	0.5	2/2	Synergy
GH 20	160	6	40/1.5	0.5	2/2	Synergy
GH 23	320	6	80/1.5	0.5	2/2	Synergy
GH 28	320	6	80/1.5	0.5	2/2	Synergy
GH 31	320	12	40/3	0.37	3/2	Synergy
GH 32	160	12	40/3	0.5	2/2	Synergy
GH 35	320	6	80/1.5	0.5	2/2	Synergy
GH 38	160	6	20/1.5	0.37	3/2	Synergy
GH 41	320	6	40/1.5	0.37	3/2	Synergy
GH 42	1280	12	320/3	0.5	2/2	Synergy
GH 46	160	6	20/1.5	0.37	3/2	Synergy
GH 49	320	6	80/1.5	0.5	2/2	Synergy
GH 50	320	6	80/1.5	0.5	2/2	Synergy

Discussion

Pseudomonas aeruginosa is a Gram-negative bacterium that develops the emergence of resistant to multiple antibiotics and responsible for the high rate of morbidity and mortality. The excessive antibiotic administrative leading to the emergence of multidrug-resistant (MDR) forms of *P. aeruginosa* that is regarded as "red-alert" that supports the need for monitoring antibiotic consumption, diagnosis, prevention, and the misuse of antibiotics. (Cassir *et al.,* 2014).

Most of *P. aeruginosa* strains were recovered from the pus culture 46% followed by sputum 22% and urine culture 14%, however, blood culture 6% and Central Venous Line, Ascetic fluid and Pleural fluid were recorded as lowest infection sites 4%. On the other hand, other studies reported that *Pseudomonas* is most commonly isolated from the respiratory tract followed by wound culture, urine and blood (Clark *et al.,* 2003). In addition, Thaden *etal.,* (2017) reported that the most common sources of *P. aeuruginosa* are in respiratory tract 25% and urinary tract 19% followed by central venous catheter and skin culture .

Our data confirm the fact that supporting the emergence of resistance in all 50 *P. aeruginosa* collected from different infection sites with variation in the resistance rate and that results consistency with the previous study on *P. aeruginosa* used traditional antibiotics with continuous increasing resistance. (Hancock and Lehrer, 1998; Hancock and Speert, 2000). Colistin is considered a promising antibiotic that still has higher sensitivity against *P. aeruginosa* as proposed in our study and compatible with Walkty and co-works, 2009).

The identification of *P. aeruginosa* is very easy but due to excessive antibiotic administration in the patients as children, the throat swab was chosen instead of sputum, the negative results can be noticed that lead to use some interstice genes target *P. aeruginosa* diagnoses as *algD* gene and Exotoxin A, the former codes for GDP mannose dehydrogenase, a vital enzyme in alginate synthesis pathway in *P. aeruginosa* at 520-bp PCR product (Deretic *et al.,* 1987; Govan & Deretic 1996; Da Silva *et al.,* 1999 and Xu *et al.,* 2004).

Exotoxin A (ETA) amplification at 396-bp region was detected in all tested *P. aeruginosa* strains, Exotoxin A is a 66 KDa protein that acts as a major virulence factor of *P. aeruginosa*, that is very toxic and can inhibit eukaryotic protein biosynthesis, similarly to toxins of diphtheria (Wolfgang *et al.,* 2003; Al-Daraghi and Husamuldeen, 2013). This approach is in agreement with other studies which provided evidence that detection of algD GDP mannose gene and Exotoxin A (ETA) can be used as a simple and specific method for identifying *P. aeruginosa.*

AgNPs have diverse applications due to their antibacterial activity and other biocompatible properties (Chernousova and Epple, 2013). Several studies stated that AgNPs can be widely synthesized in numerous ways such as physical, chemical, photochemical, irradiation, laser, green synthesis and biological methods (Iravani, 2014).

The antimicrobial activity of synthesized nanoparticles depends greatly on the size, shape and surface modification by various capping agents. Studies postulated that as the nanoparticle diameter decrease, the antibacterial activity of AgNPs increase and that was confirmed with our study where AgNPs with average size 19 ± 2 nm, showed a

great effect on all tested *P. aeruginosa* strains at MIC 6-12 mg/L. Morones *et al*., 2005, Panacek *et al.,* 2006, Zhang *et al.,* 2014. Divya *et al.,* 2019_study the antibacterial activity of AgNPs sized (30-50) nm against *P. aeruginosa* and the MIC of *P. aeruginosa* was at 30-40 mg/l.

The effect of shape was shown in our results, spherical AgNPs have a great antimicrobial activity on all tested *P. aeruginosa* that was inconsistence with other studies postulated that triangular or hexagonal AgNPs show better antibacterial activity than spherical AgNPs (El-Zahry *et al.,* 2015; Singh *et al.,* 2015).

Various reports have been providing the shreds of evidence that all synthesis methods of silver nanoparticles were used as a powerful tool against multidrug-resistant bacteria, a chemical method as showed by Lara *et al.,* 2010; Rai *et al.,* 2012. In addition, Kora and Arunachalam, (2011) showed that silver nanoparticles synthesized by UV photo-reduction method are showing promising antibacterial activity on *P. aeruginosa* at very low concentrations. Saleh and Attia, (2016) showed a high antimicrobial activity of bio-AgNPs synthesized using orange peels against *Salmonella Typhi* and *S. Typhimurium.*

On the other hand, no interaction appeared when spherical ZnO NPs applied with average size 20 ± 5 nm ,This result is agreement with Niakan *et al.,* (2019) who found that zinc oxide nanoparticles did not cause any inhibition for *Pseudomonas* growth. Although Yousef, *et al*., (2012) who found that ZnO NPs have the lowest effect of pathogenic strains used. In our study, the principle for using inorganic oxides ZnO NPs as antimicrobial agents is that they contain environmentally safe mineral elements essential to humans and have strong activity (Yousef, *et al*., 2012).

In addition, Bayroodi and Jalal, (2016) reported that standard *P. aeruginosa* strains were more susceptible to ZnO NPs than clinical *P. aeruginosa* strains with MIC values of 93.7 and 375 mg/l, respectively. These differences may be attributed to strains used as recorded by Yousef and colleges, (2012) and the differences in the preparation methods of ZnO NPs. Other probable cause may be due to the size of ZnO NPs, where in Saadat, *et al.* (2013) have used ZonONPs in the range from 30-90 nm also Aysaa ; Salman, (2016) used ZnO NPs 29 nm when compared with our results sized 20 ± 5 nm.

The antimicrobial activitiy of biologically synthesized AgNPs were assessed with commercially available antibiotics against bacteria , the highest synergistic effect was observed with ampicillin and AgNPs combination against *E. coli* than when used chloramphenicol, erythromycin, and kanamycin (Fayaz *et al.,* 2010),

In similar studies, AgNP treatment also showed synergistic effects that with the antibiotics polymixin B and rifampicin, and an additive effect with tigecycline against carbapenem *A. baumannii* isolates. On the other hand, on the combination with antibiotics, the synergistic action increased as suggested by (Habash *et al*. 2014).

Depending on the previous results, we used silver nanoparticles in combination with ciprofloxacin to exhibit the synergistic effect on the clinical *P. aeruginosa* strains. The combination of antibiotics with nanoparticles was a promising approach to restore the activity of antibiotics with the lowest concentration instead of discovering new antibiotics and avoid the toxicity of synthetic chemicals.

Conclusion:

The frequency of the prevalence of *P. aeruginosa* in Egyptian hospitals has been increased over time, to control that pathogen, the surveillance has been monitoring. The antibacterial activity of ciprofloxacin was augmented when impregnated with AgNPs. On the basis of the results from this study, we can deduce that combination of AgNPs may be a promising strategy to eliminate the MDR pathogens. Moreover, Ag NPs have the potential as an adjuvant for the treatment of bacterial infection.

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دمج السيبروفلوكسسين مع جزيئات الفضه المتناهيه الصغر لعلاج عدوي سيدوموناس اوريجنوزا فى مصر

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الملخص العربي:

تعتبر بكتريا السيدوموناس اوريجنوزا من اشرس انواع البكتريا نظراً لمقاومتها للعديد من المضادات الحيويه في المستشفيات. الجزيئات المتناهيه الصغر من اهم العلاجات المؤثره في علاج عدوي السيدوموناس اوريجنوزا. وكذلك العلاج بواسطه دمج الجزيئات المتناهيه الصغر مع المضاد الحيوي يعد من افضل الطرق في معالجه البكتريا. في هذه الدراسه قد تم استخدام جزيئات الفضه المتناهيه الصغر المدموجه مع السيبروفلوكسسين معا لدراسه تاثيرهم علي ٢٤ عينه من السيدوموناس اوريجنوزا المقاومه للعديد من المضادات الحيويه وخاصه السيبروفلوكسسين. وقد تم تجميع خمسون عينه بكتيريه من عده اماكن للاصابه و تم تعريفها بتحديد جينات algD و Exotoxin A . تم أختبار حساسيه عزلات السيدوموناس اوريجنوزا للمضادات الحيويه بواسطه طريقه الاقراص و وجد ان السيدوموناس اوريجنوزا كانت أكثر مقاومه للمضادات الحيويه. و بتعين أقل تركيز من السيبروفلوكسسين و جزيئات الفضه المتناهيه الصغر كان يتراوح بين ١٢٨٠الي ١٦٠ , ٦ الي ١٢ ملجرام/ليتر. معملياً, التأثير الايجابي ظهر عند دمج جزيئات الفضه المتناهيه الصغر مع السيبروفلوكسسين و زياده في تأثير السبروفلوكسسين. وبناءا عليه يمكن القول بان الدمج بين جزيئات الفضه المتناهيه الصغر المدمجه مع السيبروفلوكسسين في علاج عدوي سيدوموناس اوريجنوزا طريقه واعده لاستعاده نشاط المضادات الحيويه.