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Investigation of structural, optical and antibacterial effect of copper nanoparticles synthesis by photoreduction

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ABSTRACT

The copper nanoparticles films has been prepared via the reduction of copper salts $CuSO_4 \cdot 5H_2O$ by UV-lamps. The irradiation time changed from 15 min. to one hour effects on the morphology of dispersed copper nanoparticles were studied. The structure properties of the films were determined by X-ray diffraction, the change on the surface morphology was observed using atomic force microscope (AFM). Finally, The optical transmission of thin films was measured by UV-VIS spectrometer, during the preparation of observed that the color of dispersion gradually changed from blue coloration, brown finally dark brown by changing with irradiation time. As well as studies the biochemical and antibacterial effect of nano colloid studying by using Pseudomonas aeruginosa, Bacillus subtitis, Escherichia coli and Klebsiella phenmoniae. The copper nanoparticles is increasing its antibacterial activities. Actions of copper nanoparticles synthesized in both above method was also observed against both gram (-) and gram (+) bacteria.

***Keywords*:** Nanocopper; photo reduction; optical properties; Antibacterial effect

1. INTRODUCTION

Copper nanoparticles hade particles size lies between (1-100 nm) which improved improve thermal and electrical conductivity, photo catalysts for decomposition of dyes of nanomedicine, bionanotechnology and in that respect nanotoxicology research, …. etc. These materials can be prepared by physical (microwave radiation or thermal decomposition), chemical (sodium borohydride, sodium sulfite) or biogen reduction of copper salts (using number of plant antioxidants). In the research used radiation methods by UV-lamp to produced nanocopper colloid size. These preparation methods are particularly environmentally friendly and cost-effective.

The antibacterial properties of copper have been known since ancient times, when people noticed that the water in copper vessels spoils much more slowly. Copper salts are successfully used for spraying plants to protect them from mildew, metal surfaces containing copper act as bactericidal materials. The literature reports on various concentrations of copper nanoparticles with bactericidal capabilities (0.025-10 mg) [1,2].

2. MATERIALS AND METHODS

The copper nanoparticles were prepared by a copper sulfate ($CuSO_4 \cdot 5H_2O$ 99%) with Sodium borohydride ($NaBH_4$) was dissolved in distilled water was purchased from Sigma-Aldrich. Cu nano colloid s prepared with $1x10^{-1}$ M a this concentration using equation (1)

$$W = Mw \cdot C \cdot v/1000 \quad \ldots\ldots\ldots (1)$$

where;
w : weight
Mw: molecular weight
C: concentration
V: volume

We using different time of radiation using UV-lamp with 125 watt, began 15 minutes, 30, 45, one hour. Increasing each other, also using cold bath to protect low temperatures to get small grain size of nanoparticles constant.

UV-Visible absorbance spectroscopy has proved to be a very useful technique for studying metal nanoparticles because the peak position and shapes are sensitive to particle size. The synthèses of nanoparticles were recorded by UV-Visible spectra at every color change (Metertech UV-Vis SP8001), light source – combined deuterium-halogen, wavelength range: 200 – 1100 nm.

AFM study carried out by (SPAA3000, Angstrom Advanced Inc. USA). The morphology of copper nano colloidal, was observed by using JEOL JSM-5200 scanning electron microscope operating at 15 kV at a magnification of 10,000×. The formation of copper nanoparticles was identified by the XRD (Rigaku), Culture media types which used Nature agar (N.A) and Eosin methylene blue (EMB) [3,4].

Bacteria have been preservation from soil using concentrations ranging from (10^{-1} to 10^{-10}) ml, this by taking 1 gm of soil and the use of screw tube as in the following Figure (1).

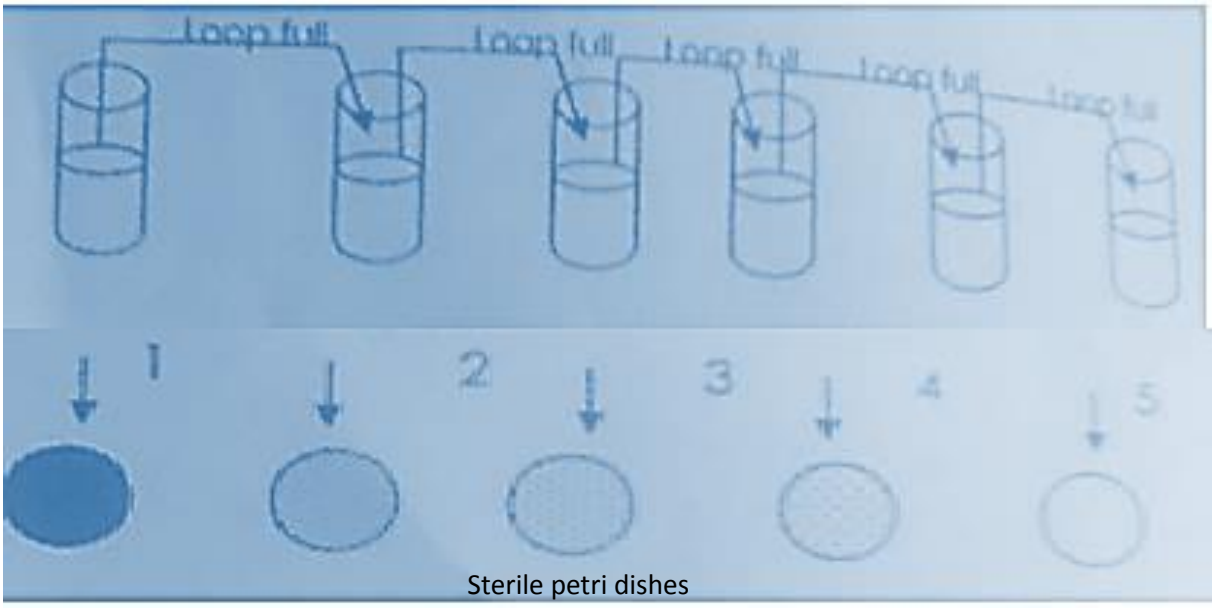

Fig. 1. Preservation Bacterial.

Then take 1 ml of the prepared bacterial concentration which pure plate contain Nutrient agar which putting on water bath to spreader. Then bacterial culture 20 petri dishes contains as a solid media Nutrient Agar (N.A.) using streak plate method, then were incubated at 37 ºC for 24 hr to ensure sterility as shown in Figure (2).

Fig. 2. Streak plate method Microscopic examination of colonies i.e.
(the biochemical tests to diagnostic bacterial types)

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Primarily each colony was tested by gram staining to identify the stain reaction and microscopic morphology of bacteria. Then incubated plate mixed with different concentration of nanocopper to diagnostic the bacterial growth to be used as agents of antimicrobial.

3. RESULTS AND DISCUSSION

Figure (3) showes that changing radiation time caused changing colors from blue coloration, brown finally dark brown by changing with irradiation time.

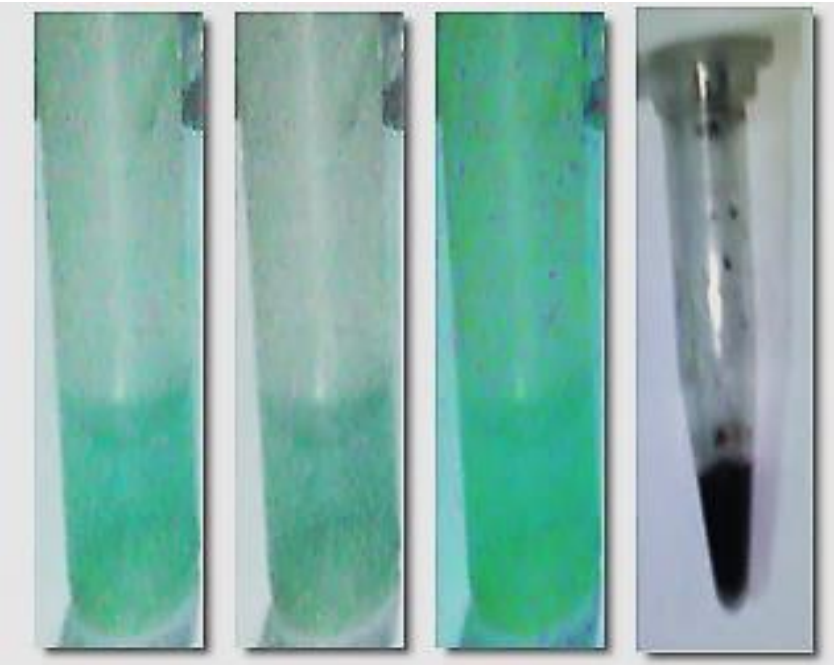

Fig. 3. Shows changed color through changing radiation time.

While, Figure (4) showed absorption spectrum of nanocopper colloid which is prepared by Photo - reduction method for different radiation time of $CuSO_4$ with $NaBH_4$ solution, from the first sight to this figure on can observe that the absorption intensity increase with increasing the radiation time while, the maximum peak absorption for surface plasmon of copper nanoparticles which has a 15 minute as a reduction period was occurred at 569 nm while for 60 minutes was occurred at 574 nm. respectively this manner is clearly illustrated in in Figure 3 and this means that the general manner of peak absorption as a function to reduction periods is "red shift" [4].

3. 1. X-Ray Diffraction Studies

In order to examine the physic-chemical make-up of unknown materials, the mineralogists and solid state chemists use primarily the Powder X-ray Diffraction techniques which are the most important characterization tools used in solid state chemistry and material science. So that Figure (5) show the X-ray diffraction for copper nanoparticles results we find three peaks (111), (200) and (220) plane of copper were observed and compared with the standard powder diffraction card of JCPDS. The XRD study confirms that the resultant particles are (FCC) copper nanoparticles [2,5].

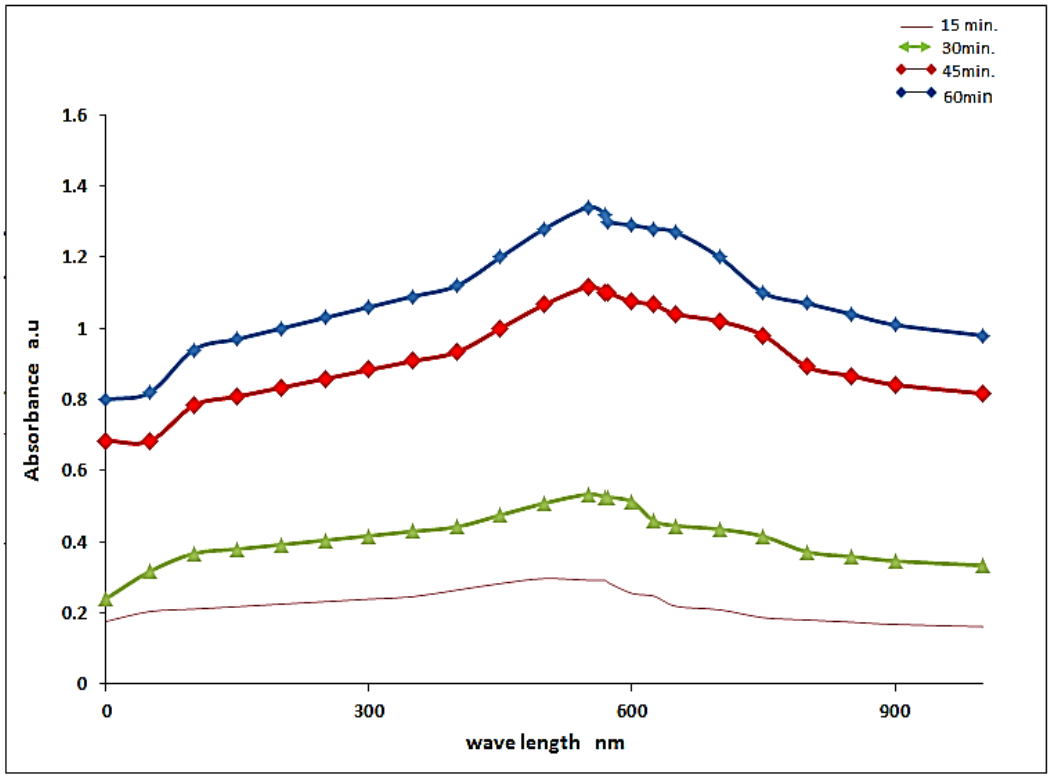

Fig. 4. Represent the absorbance intensity as a function to reduction time.

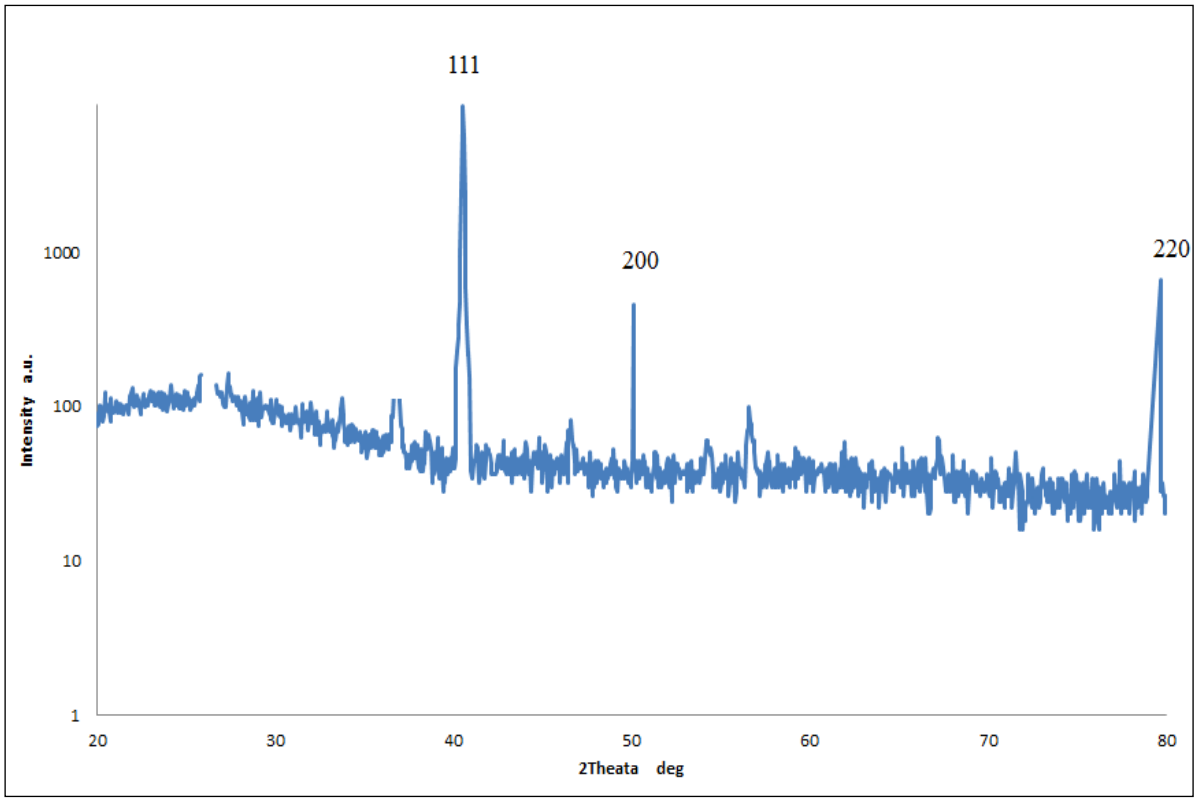

Fig. 5. Show the X-ray diffraction.

Atomic Force Microscope Explorer Thermo Microscopes was used as an indirect method for morphological analysis of the sample. Maximum scanning size of the microscope probe was (*10x10 μm*). Resolution of AFM was (*300x300 pixels*). The sample used in this thesis was measured in tapping mode. Nominal diameter of tip was (*10 nm*). The reason for the usage of AFM for nanotubes analysis is very simple. AFM is a powerful tool in manipulating and characterizing the properties of nanostructures due to these method atomic planes of nanoparticles can be observed. Figure (6) [6-8].

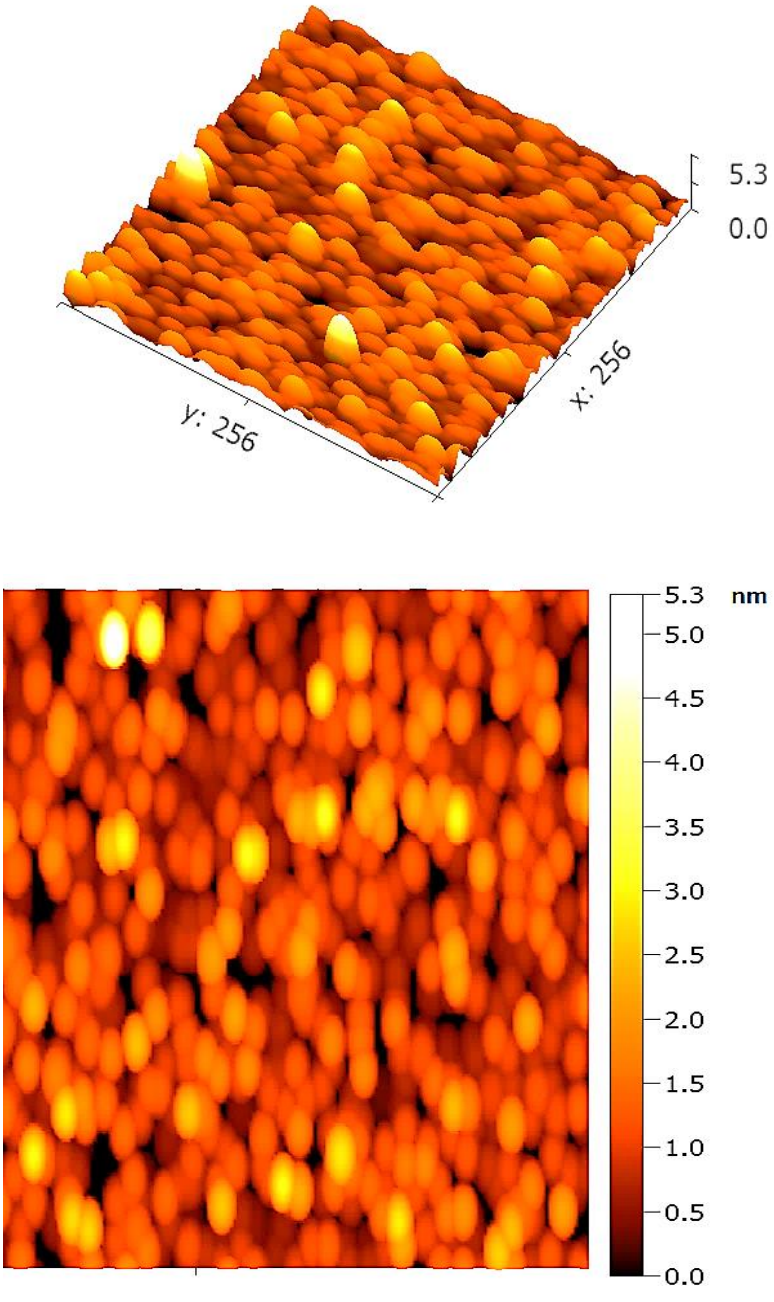

Fig. 6. Show the atomic force microscope results for CuNPs.

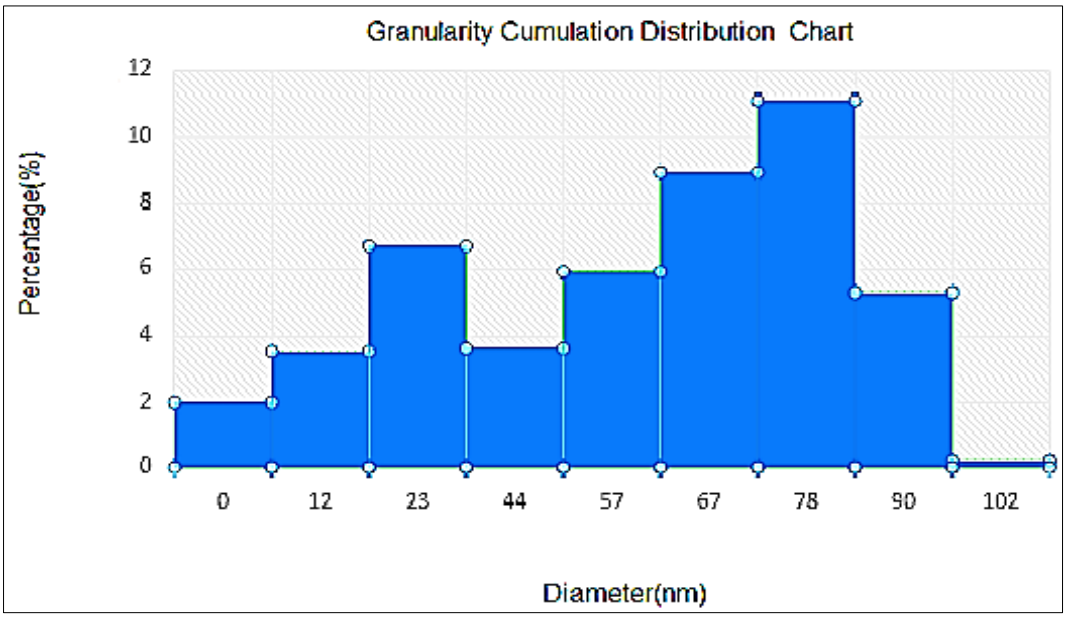

Fig. 7. Particle size distribution for copper nanocollid.

Figure (7) show particle size distribution for copper. From this figure one can see the range of the particle diameter between (1-102 nm) but the average the particle size 49.8 nm

3. 2. The bactericidal effect

Copper nanocollidal metal nanoparticles as the bactericidal effect has been attributed to their small size and high surface to volume ratio, which allows them to interact closely with microbial membranes and is not merely due to the release of metal ions in solution. The main application of the fabricated membrane will be purifying fresh or drinking water from bacteria, mainly *Staphylococcus aureus* and *Escherichia coli*. Bacteria are a large group of prokaryotic microorganisms, usually with few micrometers length. The main bacteria division is connected with retaining the crystal violet dye in the Gram staining protocol, in the research used staphylococcus aureus, pseudomonas, bacillus and Klebsilla bacteria effect to using it as the antibiotic.

In order to obtain pure viable cultures, bacteria had to be suspended in tryptic soy broth (TSB) purchased from Sharlau Chemie S.A, Method of examining bacterial effect through streak plate method which it is spread a limited amount of bacterial by wire loop as cold and sterile carrier and plan its surface [9].

From the streak toward one and then sterilized Alnmtqh to ease the preparation of the bacteria by publication, then it is burned carrier ring dishes incubated for 24 hours and at the last examination of the area will find they contain on a single transferred to another dish for the growth of pure colonies [10,11].

After that has been added to different concentrations of nano copper material ranged from 0.1 to 1 mg was the bosom of dishes for 24 hours at a temperature of 37° Slelezih found that the forms of the bacteria (*E. coli*), while we note that bacterial growth when using the first focus of growth has increased Bacterial all types of bacteria used in the search, but that when the Supreme focus has been the elimination of all kinds of bacteria, which confirms that

the copper nanoparticles Balabaada reduces bacterial growth the greater the focus and therefore we can use it as anti-bacterial growth, from Figure (8) showed the bacteria shape.

While Figure (9) showed the bacteria growth with different concentration of copper nanocollid effect on bacterial test.

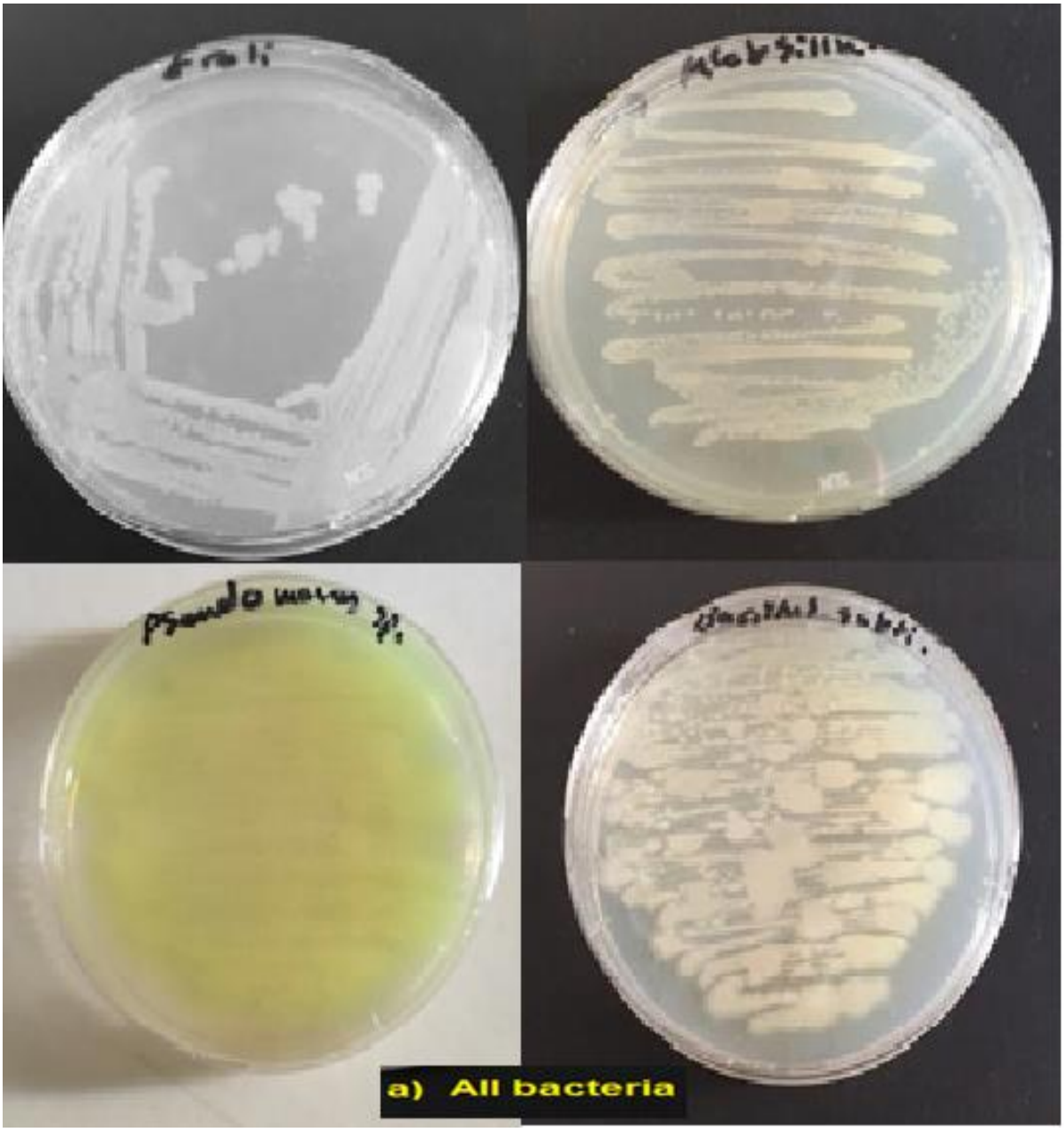

Fig. 8. Showed the bacteria shape.

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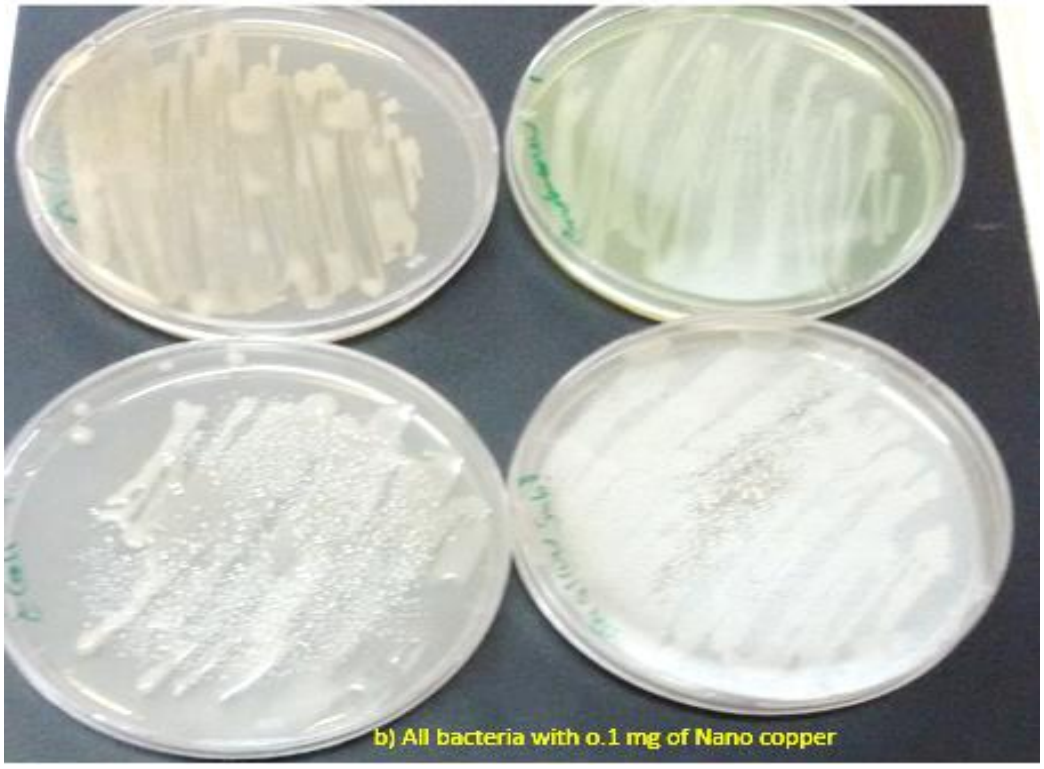

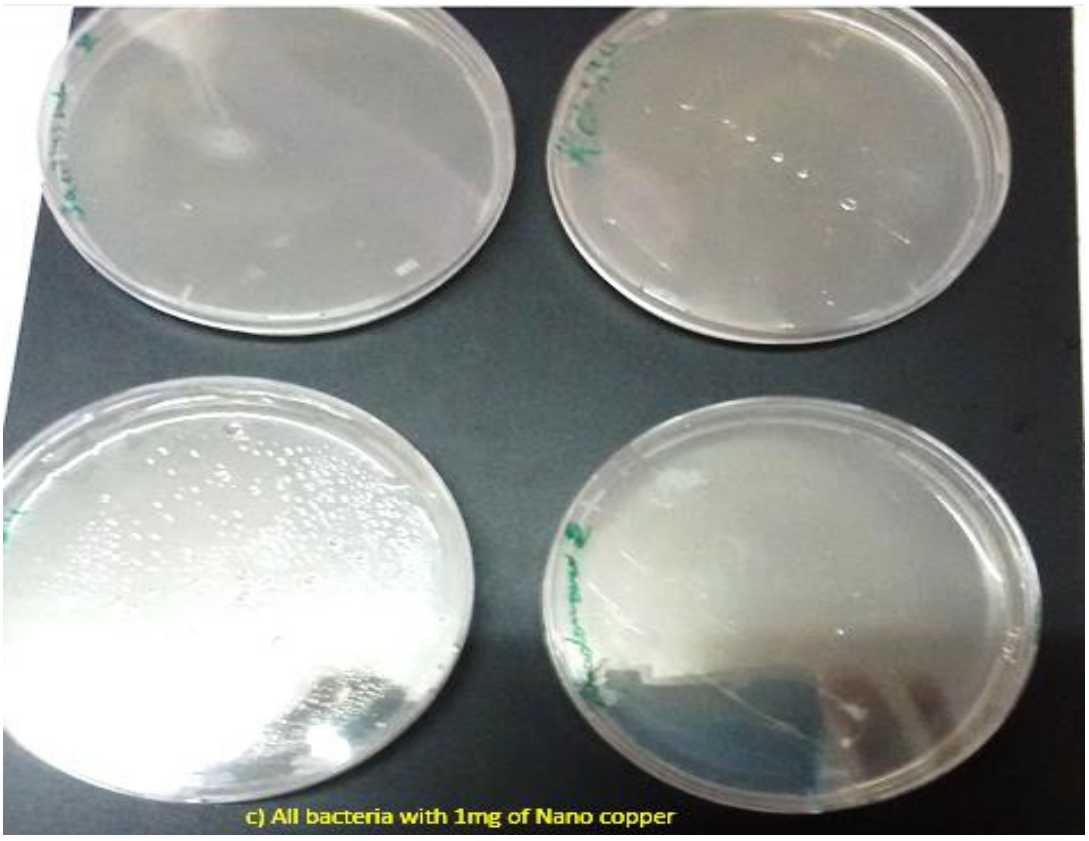

Fig. 9. Showed the different concentration of copper nanocollid effect on bacterial test b) at 0.1 M , c) 1 M.

From results showed that at 0.1 M concentration of nanocopper the bacterial which growth, but high concentrations at 1 M of copper nanoparticles demonstrate complete cytotoxicity against *E. coli* [12]. These nanoparticles adhere to the bacterial cell wall and penetrate through the cell membrane. This disposition of the same when you use a other types of bacteria with less changed.

4. CONCLUSIONS

The synthesis method which consider as low cost, environmental friendly and can be prepared in simple laboratory equipment in ambient condition. In addition to prepared minimum particle size for copper nanoparticles was 49.8 nm

Where the morphologies of the Cu-NPs were also significantly dependent on pH and ionic strength. The increase in irradiation time increased the intensity of the absorption solutions also increase the pH. Also the colloid colors changed from colorless.

That all bacteria types when increasing the copper material of concentration (0.1 to 1) mg led to the killing of all bacteria in the *E. coli* kinds but have remained at less than this effect act as an inhibitor of bacterial growth.

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