K. H. Jwaid
medical Engineering Department- University of Technology, Iraq .
karimuot@yahoo.com .

M. S. Jabir
Applied Science Department, Biotechnology branch University of Technology, Iraq .
Majid applied@ yahoo.com.

U. M. Nayef
Applied Science Department, University of Technology, Iraq .
Udaynayef@yahoo.com

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A study of kidney Parameters Induced by Porous Silicon Nanoparticles

Abstract- *Nanoparticles are a special group of materials with unique features and extensive application in diverse fields .The present work demonstrates the toxicity effect of porous silicon nanoparticalse on kidney parameter which is prepared by electrochemical etching method. We conformed the synthesis of porous silicon nanoparticles by using structures and optical properties from through scanning electron microscope techniques and measuring absorbance of color. The study of toxicity effect of these nanoparticles on the kidney parameters in laboratory animals by used five groups was studied. Injected of porous silicon nanoparticles in the intraperitoneal at concentration of 1mg\kg. The results of biochemical assay (urea and creatinine) compared with the control groups, for a period of four weeks was confirmed with Histology section of kidney. Our results showed that no significant differences in levels (urea and creatinine) between the test groups when compared with controls groups. This Results indicates no toxic effect of porous silicon nanoparticles in kidney parameters*

Keywords *- porous silicon nanoparticles, biochemical assay, histological.*

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1. Introduction

porous silicon nanoparticles (PSNPs) have been widely developed for different biomedical uses, for example cancer cell imaging ,biosensors, drug delivery, radiotherapy and photo thermal therapy because of their easy surface modification as well as optical properties and electronic [1]. PSNPs are presently used in the treatment of rheumatoid arthritis and cancer [2]. Usually, porous silicon (PS) has been considered inert and biocompatible. Nanoparticles possess single properties unlike from bulk-sized materials, involved volume ratios*I.* to large surface area, strong interaction with biological conditions, in height reactivity, and related to their less size. The studies on the toxicity of PSNPs has been described in vitro and in vivo [3]. Conflicting results have been demonstrated, depending on experimental conditions, such as particle size, cell lines, concentration, animal models and surface chemistry used [4]. Toxicity of PSNPs (13.5 nm) was also recognized in mice by intraperitoneal injection ,oral and intravenous, respectively, viewing that tail vein injection of PSNPs had fewer toxicological effects compare oral or intraperitoneal injection [5]. Actually, record toxicity studies in vivo of PSNPs have been examined by intravenous injection or intraperitoneal, although its toxicity by oral exposure has not been widely explored. The application potential of PSNPs in therapeutic agents or oral delivery carriers has been focused on and requirement further verification on their oral toxicity [6]. Biokinetic activities of PSNPs, including tissue distribution design and oral absorption efficiency have not been well determined, which can provide major information on their potential toxicity and biomedical at harmless levels. this study was desinged to evaluate toxicity PSNPs after dose injection to mice.

2-Materials and Methods

I.Preparation of Porous silicon nanoparticles

Porous silicon samples were prepared from single crystalline orientation of p-type silicon wafer (100) and with resistivity 1.5-4Ω.cm (Germany made) and the thickness of silicon wafer is (550±50µm). All chemicals, hydrofluoric acid, ethanol alcohol, were purchased from Sigma Aldrich (Malaysia). Before Electrochemical etching process, the silicon wafers were rinsed with ethanol and action to remove dirt followed by dilute (24%) hydrofluoric (HF) acid to remove the native oxide layer and dried by nitrogen (N_2) [7]. In a Teflon cell containing the current density at 200mA/cm^2 for 2 hrs. and the removed PS layer wafer by freestanding ,washing &dry, milling system, mixed 0.1g powder PS with 2.5 and 25ml dD.W, flittering 220nm, ultrasound System (4 hs. replicate 4 times) and posting by high power laser (*Nd:YAG* laser) [8].

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2412-0758/University of Technology-Iraq, Baghdad, Iraq

II. Characterizations of PSNPs

UV-Vis spectrophotometer The absorbance was measured in the wavelength range of 250-1100nm . The optical absorption spectra of the PSNPs colloids at unlike preparation conditions within the spectral range (200-1100nm) for PSNPs. The optical absorption spectra of using pours silicon nanoparticles showed absorption peak around 444nm [9].

A Scanning electron microscope (SEM) uses a collimated and focused beam of in height energy electrons to produce images from sample's surface. When it reaches the sample, the electron beam scans the sample surface by a series of deflection coils. Two independent detectors collect the secondary electrons for images with better resolution, and the backscattered electrons for topographic, compositional or electronic maps. The PSNPs imaged by SEM microscopes (Nova-Nano SEM 430-USA) instrument was used and achieved in Department of Applied Science, University of Technology[10].

Laser and Irradiation a pulsed Q-switched *Nd: YAG* laser system at 1064nm wavelength with maximum energy 350mJ per pulse was used for treatment samples. The output pulse duration is 9ns and repetition rate 1Hz. Beam diameter of 2.4mm was used for post laser.

III. Experimental Design

Albino male mice were supplied from the Biotechnology Research Centre (Al-Nahrain University). Their ages at the start of experiments were 8-10 weeks, and their weights average was 20-25gm. They were distributed in to five groups each group contains three mice, and was kept in a separate plastic cage (details of these groups are given in the section of experimental design). The animals were maintained at room temperature, and had free excess to food and water. In this experiment, 1mg/kg was doses of PSNPs, and assess the toxicity effects of this dose, the mice were distributed into five groups, and each group contains three animals (total: 15 mice):-

- Group I: Mice were administrated with physiological saline (Negative controls).
- Group II: (Injection PSNPs), Killing after week .
- Group III :(Injection PS NPs), Killing after two weeks.
- Group IV: (Injection PS NPs), Killing after three weeks.
- Group V: (Injection PSNPs), Killing after four weeks.

End of the testing, mices were killing and the blood collected by trans cardiac puncture 6 hour after administration of the test compound. Serum was collected by centrifuging blood sample at (6000) rpm for ten min. and stored at (-20) C° keep used, for the purpose designed the following biochemistry tests such as Urea, Creatinine, and the sections of kidney by a pathologist.

IV Assessment kidney parameters of effects

Serum Creatinine was measured, after deproteinization; according to the Jaffe reaction using commercially available kit (Bio Merieux. France). determined spectrophotometrically in the supernatant by absorbance at 520 nm, By Equation. Result Total Creatinine conc.

$$(\text{mg/dL}) = \frac{(R2-R1)\text{Serum}}{(R2-R1)\text{ Standard}} \times 2$$

Urea Blood urea was measured by enzymatic method of Chaney with commercially available kit (Bio Merieux. France). Determined Blood urea spectrophotometrically by absorbance at 580 nm. By Equation:-

$$\textbf{Result Blood urea} = \frac{\text{A Serum}}{\text{A Blank}} \times 50$$

3-Results and Discussion

The absorption of light is produced via electronic transitions in the pattern. The intensity of the absorption and the specific wavelengths that are absorbed give us information about the electronic construction of the pattern . The UV-Vis absorption spectrum wavelengths that are absorbed give us information about the electronic construction of the pattern . The UV-Vis absorption spectrum of the made compound nanoparticles Prepared by electrochemical etching of pours silicon nanoparticles pattern of measured in the wavelength (250-1100nm). Figure (1) shows the UV-Vis optical absorption spectra of PSNPs there was absorption peak about 444nm .The optical absorption edges shifted slightly towards longer wavelength (red shift). This shift resulted from the increase in particle size[11].

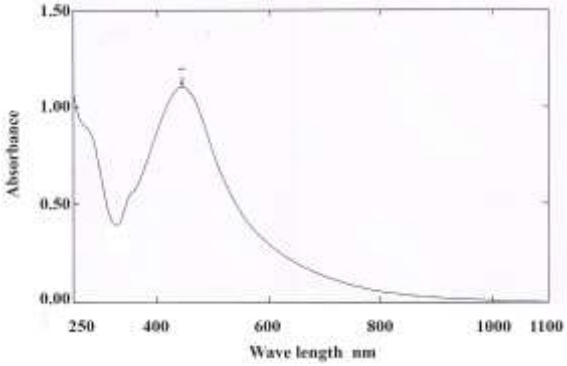


Figure.(1) UV-Vis characterization of PS nanoparticles.

Figure (2) SEM image to determine the optimum morphology of the PS formed. The pores diameter, calculated by Image J software, ranged between 10 to 50 nm .The pores appear uniformly distributed throughout the structures suggesting an appropriated fabrication method. SEM image show the uniform surface with some void spaces. Instead of spherical shapes elongated rod-like architecture with rough surface is noticed.

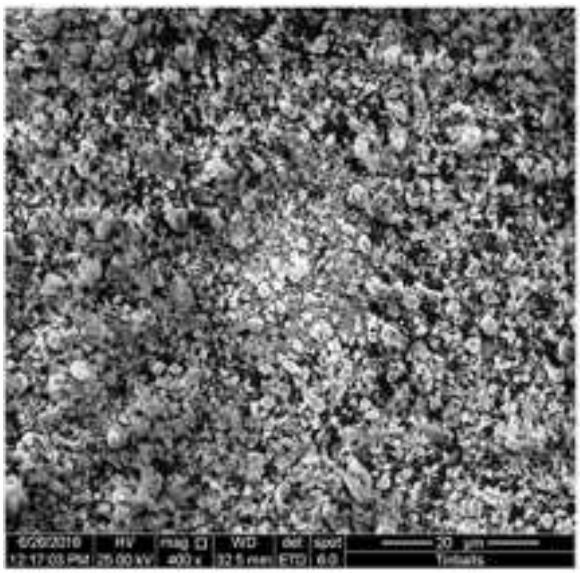


Figure. (2). SEM image of porous silicon nanoparticles.

Figure (3) in the urea concentration in serum of mice treated period 1 week and 4 weeks after (1) mg\kg PSNPS injection. our results shows no significant differences in levels urea between the test groups in compared with controls groups .

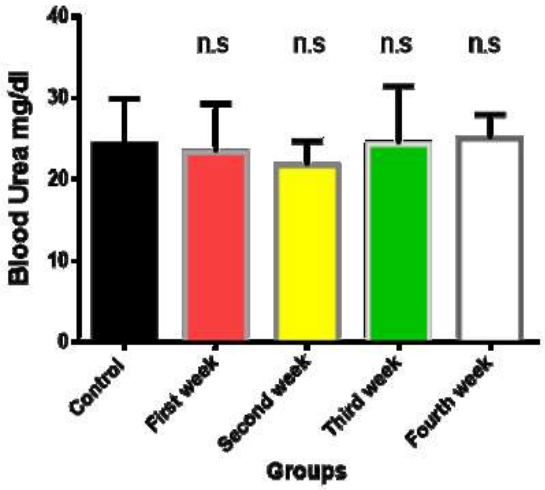


Figure.(3) Level of urea in mice treated with PSNPs at a injection of (1)mg/kg.

Figure (4)shows the creatinine concentration and again no significant differences in levels Creatinine between the test groups in compared with control group .

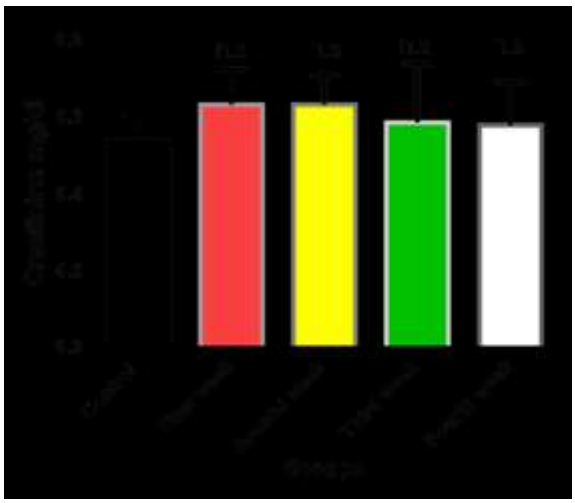
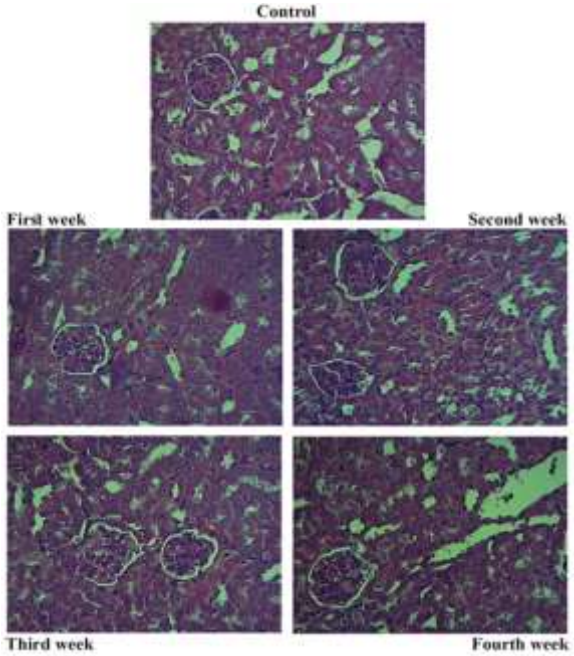


Figure.(4) Level of creatinine in mice treated with PS NPs at a injection of (1) mg/kg .

The results of histology showed no differences between control group and treated groups. No significant change in morphology in Kidney samples and normal structure appearance of a renal tissue in mice, which consists of glomeruli and renal tubules. Figure (5) shows the normal structure appearance of kidney in mice after PSNPs treatment.



Figure(5)Histopathological examination of kidney after 1 week - 4 week intraperitoneal injection of PSNPs at dose (1) mg/kg .

We investigation biocompatibility and biodegradability of PSNPs *in vivo.* The PS NPs preparation is relatively non-toxic *in vivo* within the examination concentration range. This result compares with the slow removed normally

observed for other kinds of inorganic nanoparticle [12]. Terminated a period of 4 weeks, *In vivo* studies, PSNPs (1 mg\ kg) were injected intraperitoneal into mice. However, the PS NPs collected in the organs are noticeably removed from the body within a period of first week and totally removed in four weeks. The mice of Porous silicon nanoparticle internalization has been shown to be determined by particle size [13]. Some factors are thought to have a profound effect on the development of mediated toxicity nanoparticle. Unique of the key factors is nanoparticle diameter, which, at minimum for colloidal nanoparticle, inversely associates with the surface area. Toxicological special effects of PSNPs in mice were more established by histopathological investigation. Figure (5) shows that no atypical in histopathological findings were shown in kidney after 4-week injection of PSNPs . This result clearly showed that PSNPs did not cause toxic effects. Pathological damage associated to the test materials was no shown in every groups treated. Porous silicon nanoparticle used in the present study did no source severe toxicity in mice.

4- Conclusions

Porous silicon reasonably biocompatible nanomaterials, at minimum when seeing acute toxicity. The intraperitoneal injection of PSNPs at of (1) mg/kg was no relatively with any variations in biochemical examination over a period of four weeks. PS NPs not shown to cause kidney failure .

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Author(s) biography

Assist. lect. Kareem H. Jwaid, Lecturer Medical engineering Department , University of Technology, Iraq. He has been working on various aspects related to laser and biomedical ,and interested in Nano materials to be used with different application medical .

Assist. Professor. Majid S. Jabir, Ph.D. .Lecturer Applied Science Department, Biotechnology division University of Technology, Iraq ,he interested in Nano materials to be used with different medical applications and clinical immunology

Professor Uday M Nayef, Ph.D. Lecturer Applied Science Department, University of Technology, Iraq, he interested in physical applied, Nano technology, laser to be used with different application medical