Journal of Nanomedicine & Nanotechnology
ISSN: 2157-7439
OPEN ACCESS Freely available online
Hypothesis

# Is Nanoparticle Efficacy is a Function of Surface Area?

**Mohd Ali***

*Department of Process and Product Development Division, Indian Institute of Natural Resins and Gums, Jharkhand-834010, India*

ABSTRACT

In the 21st Century, human has made an enormous advance in the field of science particularly in the area of nanotechnology and finds wide application in the fields of environmental protection, hygiene, therapy, and agriculture due to the high efficacy of nanoparticle. But the actual reason for the higher efficacy of nanoparticle is yet not clear in the true sense. Researchers consider that the nanoparticles show higher efficacy/toxicity due to their large surface area. But on the other side, the researcher also reported that non-spherical nanoparticles also shown the same or some times higher toxicity or efficacy than spherical nanoparticles. Therefore, this hypothesis is made to explain; why some times non-spherical nanoparticles show the same or higher efficacy/toxicity instead of having low surface area than a spherical nanoparticle.

**Keywords:** Nano-particles, Macro-particles, Atoms/Ions/Molecules, Surface Area, Bio-efficacy, Toxicity

## INTRODUCTION

The fast-changing world has drifted from the Stone Age to the nanotechnology age surpassing every stage like the chemical age, silicon age, biotechnology age, etc. Today nanotechnology has made rapid progress and is applied widely in the fields of environmental protection, hygiene, therapy, and agriculture [1-3] due to the high efficacy of nanoparticle at low dosage.

Researchers around the world have proposed that the higher efficacy of nanoparticles is due to their large surface area [4,5]. If it is so, then the efficacy/toxicity of the solution and spherical nanoparticle must be higher than the nanoparticle and non-spherical nanoparticle, which is not so true practically [2,3,6]. It implies that there is no such relationship between the surface area and the efficacy of nanoparticles!

## HYPOTHESIS

The bio-efficacy/toxicity of the nanoparticle depends on the number of atoms/ions/molecules per nano-particle but not on the surface area.

### Justification of Hypothesis

This can be easily understood from the following equation.

Toxicity/Bio-efficacy= Time of exposure × Dose (Equation-1)

Here dose means the total amount of active ingredient applied.

As per this equation, the bio-efficacy/toxicity of the same compound of different formulation (solution, nano, and macro) at the same dose and time must be the same. But in practice, it's not so. The different formulations can only show differences in bio-efficacy/toxicity at a constant time; when the definition of dose in the above equation 1. is changed to the number of atoms/ions/molecules per particle from the total amount of active ingredient applied.

Therefore;

Toxicity/Bio-efficacy= Time of exposure × Number of active atoms/ions/molecules per particle. (Equation-2)

Further, the toxicity of a compound depends on; dosage, time, exposure route, the ability of the chemicals to be absorbed, species, age, sex, metabolism, distribution within the body, excretion, and presence of the other chemicals [7]. If these variables are kept constant and the bio-efficacy/toxicity of the same active atoms/ions/molecules of the different formulations (Solution, Macro and Nano) and the different shaped nanoparticle is measured using equation 2. Then only, the different formulations and the different shaped nanoparticle of the same active atoms/ions/molecules will show differences in bio-efficacy/toxicity. This supports the hypothesis, that bioefficacy/toxicity of nanoparticle depends on the number of active atoms, ions or molecules per nanoparticles but not the surface area.

## EXPLANATION

**Case 1:** If the active ingredient is in the form of a solution, its penetration rate, as well as the rate of dilution and distribution in the living system, will be very high, due to which the sufficient quantity of the active ingredient does not reach the site of action.

***Correspondence to**: Mohd Ali, Department of Process and Product Development Division, Indian Institute of Natural Resins and Gums, Jharkhand-834010, India, E-mail: mdali20117@gmail.com

**Received:** March 16, 2021; **Accepted**: April 19, 2021; **Published:** April 26, 2021

**Citation:** Ali M (2021) Is nanoparticle efficacy is a function of surface area? J Nanomed Nanotech. 12: 562.

Therefore, a higher dose of the active ingredient is required to kill or inhibit the target organism as compared to the nanoparticle at a given dosage and time.

**Case 2:** When the active ingredient is in the form of micro-particles, there will be a very slow rate of penetration due to their larger size, which leads to a higher dilution/distribution rate in the living system. As a result, a very small amount of active ingredient reaches the site of action. Because of these, the macro-particle shows lower efficiency compared to nanoparticles at a given dosage and time.

**Case 3:** Nanoparticles show higher bio-efficacy/toxicity at the same dosage and time. Nanoparticles, due to their smaller size resulting in their higher rate of penetration and the rate of dilution and distribution in the living system, but there is enough active ingredient carried per nanoparticle to kill or inhibit the target organism once it reached the target site. So we need a lesser dose or time to kill or inhibit the target organism as compared to solution and macro form.

Pico-sized particles yet have not been prepared. They may show higher or lower bio-efficacy/toxicity than the nanoparticles, depends only on the number of active ingredient per particle. If the Pico-sized particle has enough active ingredients to inhibit the target site in organisms; then their bio-efficacy/toxicity will be higher than the nanoparticle at the same dosage and time and Vice versa. With further reduction in the size of the particles, a stage will come and the further reduction in the size of particle will reduce the bio-efficacy/toxicity of active ingredient per particle.

## CONFLICTS OF INTEREST

I am here by saying that there is no any conflict of interest with any early published research articles. This manuscript is hypothetical in nature and based on my experience and knowledge in the area of nanotechnology.

## REFERENCES

1. Wan-Jun S, Wei-Wei S, Sai-Yan G, Yi-Tong L,Yong-Song C. Effects of nanopesticide chlorfenapyr on mice. Toxicological and Environ Chemistry. 2010; 92(10):1901-1907.
2. Helmlinger J, Sengstock C, Groß-Heitfeld C, Mayer C, Schildhauer TA. Silver nanoparticles with different size and shape: equal cytotoxicity, but different antibacterial effects. RSC advances. 2016; 6(22):18490-18501.
3. Pal S, Tak YK, Song JM. Does the antibacterial activity of silver nanoparticles depend on the shape of the nanoparticle? A study of the gram-negative bacterium Escherichia coli. Applied and environmental microbiology. 2007;73(6):1712-1720.
4. Shin SW, Song IH, Um SH. Role of physicochemical properties in nanoparticle toxicity. Nanomaterials. 2015;5(3):1351-1365.
5. Namdari M, Eatemadi A, Soleimaninejad M, Hammed AT. A brief review on the application of nanoparticle enclosed herbal medicine for the treatment of infective endocarditis. Biomedicine & Pharmacotherapy. 2017; 87: 321-331.
6. Toy R, Peiris PM, Ghaghada KB, Karathanasis E. Shaping cancer nanomedicine: the effect of particle shape on the in vivo journey of nanoparticles. Nanomedicine. 2014; 9(1):121-34.
7. Hayes WJ, Laws ER. Handbook of pesticide toxicology. 1991.