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Silicon dioxide Nanoparticles Linear Modeling with Aqueous system for direct Agricultural Applications.

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Abstract: *The usage of nano-silica dioxide particles with the protection of agricultural products has drawn a lot of interest due to the increased demand for new materials with improved mechanical, thermal, and physicochemical properties. Nano-sized silica particles and their derivatives have been recognized as a reliable approach with a variety of scientific applications. In this regard, a java-based nanoparticle application was adopted in modeling the preparation of a nano-silica powder for direct applications in agriculture especially. Nano-diameter of 100nm, aqueous solution volume of 100ml, and powder mass of 1 to 10mg were predicted for the generated linear model of* $y= 1.1976x + 0.00013; R^2=1$ *with the nanoparticle solution concentration and the powder mass. The activity of nano-silica as a filler for the production of polymer nanocomposites is indeed a suitable method to boost the value of food packaging technology to the shelf-life quality of food products.*

Keywords: Nano silica powder particles, agricultural products, nanoparticle application, aqueous solution, and silicon dioxide

1.0 INTRODUCTION

Globally, humanity is confronted with the problem of processing high-quality food components against the numerous chemical factors in form of pollutants, pesticides, and toxic additives as consumed without consciousness. Meanwhile, the nanotechnology objectives in food industries are food security measures, particularly around pathogen identification, distribution of bioactive molecules, food preservation, and packaging, [1]. Nanotechnologies have been applied successfully in agro-food development, as many primary studies have centered on traditional agricultural methods which cannot boost productivity [2]. New techniques have been introduced in nanobiosensing techniques in the detection of a wide spectrum of moisture, fertilizers, pesticides, and other necessary factors with crop diseases [2]. Thereby, consumer's demand for safe foods has thus motivated scientists in adopting nanotechnology with food and nutrition like nanomaterial binding of packaged foods, and Nano sieves in the filtration of the pathogenic organism [2]. Also, nanotechnology has led to the production of food additives that can enhance the nutritional assessment of food products and extend their shelf-life with enhanced properties [2]. Most agricultural products with engineered nanoparticles such as silica are now readily accessible as additives and as Nano-silicon encapsulation technology for the production of synthetic colours, aromatic compositions, and preservatives [3]. Hopefully, these innovations would enable materials that are poor and not soluble in water to be distributed and improving the absorption rate of the encapsulated additives or nutrients [2]. Similarly, food packaging occupies the biggest category of nanotechnology applications with the food industry as packaging materials that interact directly with the food products tend to enhance and retains the quality [4]. Typically, nanoparticles of silica have been applied as agro product preservatives because of their small dimensions of about 100 nm in diameter which induced their interesting characteristics. As particle size decreases, the specific nanoparticle surface area increases as it allows significant improvement in surface distribution and water absorbability. Silica is a silicon and oxygen compound popularly known as silica, and the elements are connected by the covalent bond as can naturally found in Quartz**.** It is white or colorless and is not water or ethanol soluble. It forms the silicate family through reaction with minerals for many industrial applications such as an additive in the food industry. It is an anti-bender, antifoaming agent, viscosity monitor, desiccant, clarifier for drinks, and as an excipient of drugs and vitamins [5]. Nanoparticles from Silica are used for seed care and agrochemicals. Food packaging biomaterials with silica nanopowder protect and preserve the freshness of the food products as it serves as antifoaming, anticoagulant, and thickening agents. The hygienic norm with the application of food additives mandates that it should be used with specified food materials [6]. Another striking benefit of a food-grade hydrophilic silica's adhesion is its wettability that helps to avoid the formation of lumps. This is because silicon dust envelops and thus operates as a binder amongst the particles of dust individually. In solution, silicon dioxide offers strong preservation of colored powders and high transparency [6]. We modeled the synthesis of silicon nanoparticle powder in terms of the diameter, concentration, surface areas, mass, and volume of the nanoparticles with a nanoparticle java-based calculator for the basic synthesis pathway.

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2.0 METHODOLOGY

Constant Silica nanoparticle diameter of 100nm and aqueous solution volume of 100ml were applied with the nanoparticle mass range of 1 to 10mg.

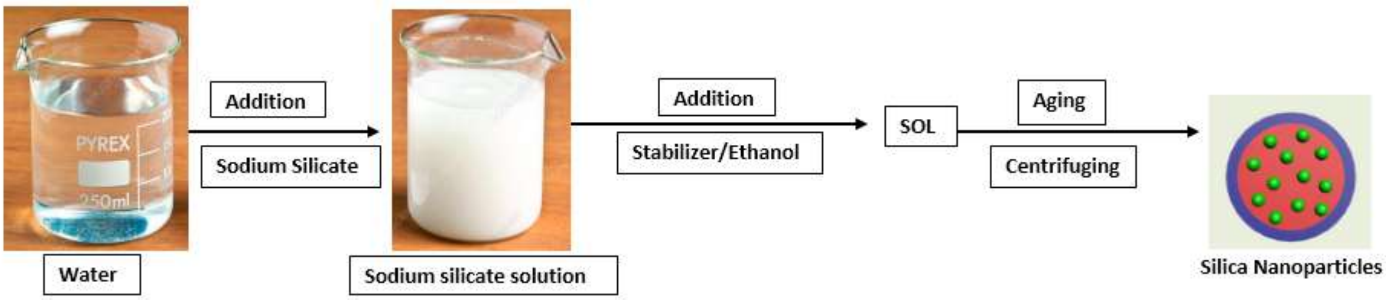

Figure 1. Typical synthesis of Silica NPs

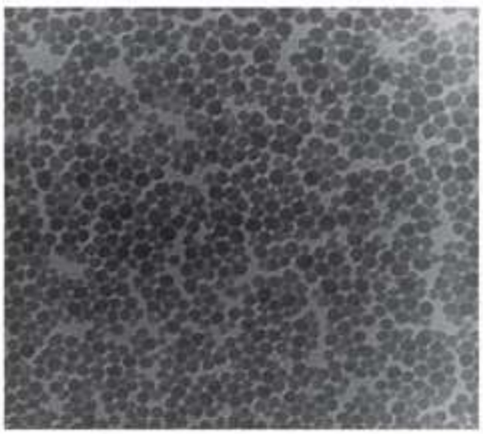

Figure 2. TEM image of S-NPs [7]

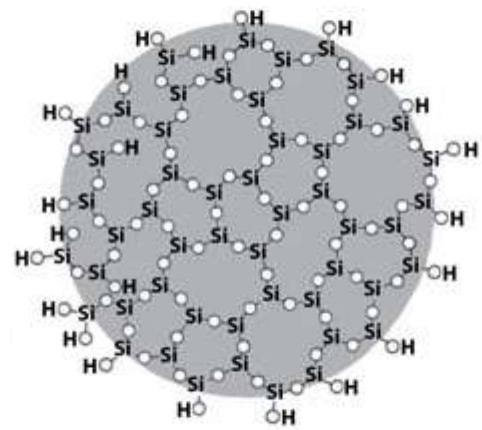

Figure 3. Surface structure of S-NPs [7].

3.0 RESULTS AND DISCUSSION

Table 1. Output data of silica NPs modeling with Nanoparticles application

SiO2 NPs Powder(mg)	Single SiO_2 NPs Surface Area (nm^2)× 10^4	Total SiO_2 NPs Surface Area (nm^2) ×10^{17}	Single SiO_2 NPs Volume (nm^3) ×10^5	Total SiO_2 NPs Volume (nm^3) ×10^{18}	Single SiO_2 NPs Mass(g) ×10^{-15}	SiO_2 NPs Solution Conc.(Mole) ×10^{-11}
1	3.14	22.70	5.24	37.80	1.39	1.20
2	3.14	45.30	5.24	75.50	1.39	2.40
3	3.14	68.00	5.24	1.13	1.39	3.59
4	3.14	90.60	5.24	1.51	1.39	4.79
5	3.14	1.13	5.24	1.89	1.39	5.99
6	3.14	1.36	5.24	2.27	1.39	7.19
7	3.14	1.59	5.24	2.64	1.39	8.38
8	3.14	1.81	5.24	3.02	1.39	9.58
9	3.14	2.04	5.24	3.40	1.39	10.78
10	3.14	2.27	5.24	3.78	1.39	11.98

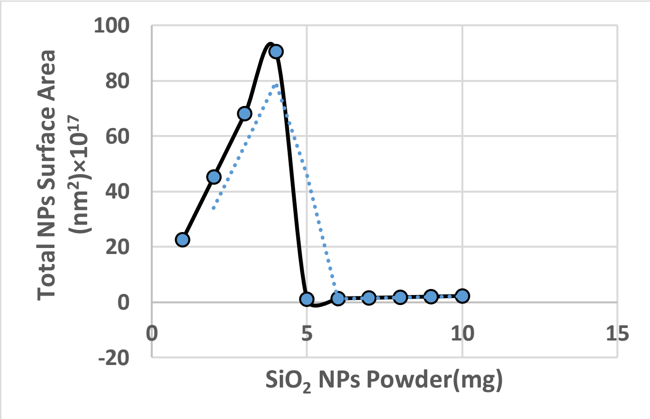

Figure 3. Total S-NPs surface area against the quantity

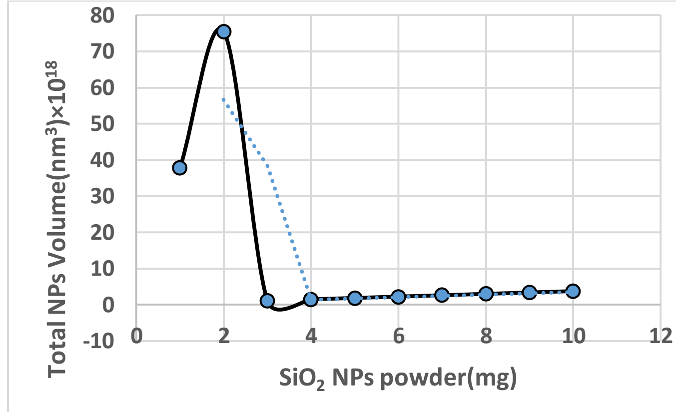

Figure 4.Total S- NPs volume against the quantity

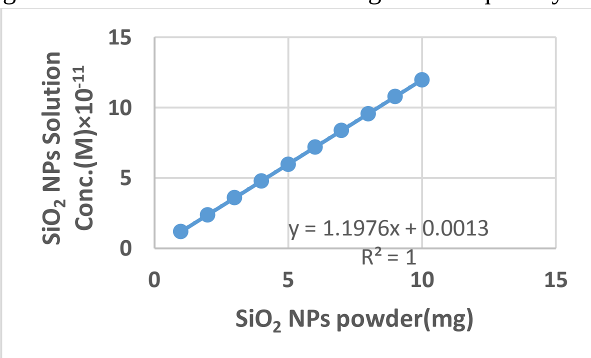

Figure 5.S-NPs Solution concentration against the quantity

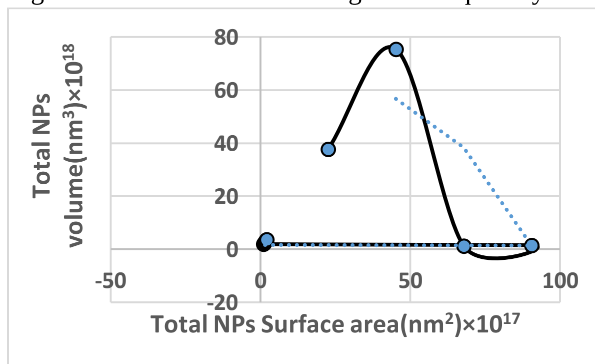

Figure 6. Total S-NPs volume against the total surface area

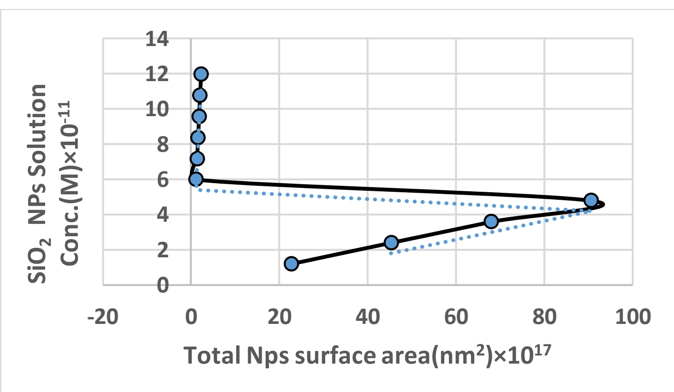

Figure 7. S-NPs solution concentration against the total surface area

The recommended silica nanoparticle diameter of 100nm, aqueous solution volume of 100ml with the powder weight of 1 to 10mg directly estimated some constant values with the surface area, volume, and powder mass of the nanoparticles. These trends could illustrate the uniform distributions of the nanoparticles in the system as the total nanoparticles surface area, volume, and the solution concentration that varies with direct proportionality with the quantity of the nanoparticles by mass (Table 1).

Figures 3, 4, 6, and 7 reflect the negative interactions and relationship between the total silica nanoparticles surface area, total volume, powder mass, and between the total nanoparticles volume with the total surface area respectively. Figure 5 established a linear relationship between the silica nanoparticles solution concentration in moles and the powder mass ($y=1.1976x+ 0.0013$; $R^2=1$). In other words, preparation of silica-based nanoparticles with regards to java based nanoparticle calculator rest on the solution concentration with the expectation of obtaining active nanoparticles (Figure 2 and 3)

4.0 CONCLUSION

The background of nanotechnology and science in the food processing industry is a recent development in nanostructure production with global security concerns. The profound benefits of nanoparticles in agriculture were accepted at a summit of professionals from the World Health and United Nations agricultural Organizations. The Administration on drug and food Nanotechnology commission was set up in the US in 2006 to formulate regulatory strategies for controlling the interaction of nano substances in nutrition studies. While all of these organizations agree in principle that nanomaterial would bring major benefits to the food sector, they also agree that the existing nanomaterial safety knowledge, as well as guidelines for risk evaluation of the adoption of nanomaterial in agro-processing, have been announced by the EFSA and USFDA in 2011 and 2012 respectively. They emphasized the point for analyzing the interactions with features like particle size and surface properties. Thence no practical advancement has been established globally concerning the safety evaluation of nanomaterial in the food industry. However, the available data on oral protection, absorption, metabolism, excretion, and risk assessment with the ingestion of nanomaterial is scarce with poorly understanding. Furthermore, with the knowledge of nanomaterial properties such as the particle shape, size, surface structures, distribution, and formation can induce some biological effects, its toxicological studies have not been established and categorized for use as quality frameworks for nanomaterial safety. So, quantitative analyses, along with the evaluation of the interactions between their properties, efficacy, biological activity, and protection, are therefore necessary. It is anticipated that such findings would disclose the scientific foundation for the evaluations needed for production and appropriate utilization of nanomaterial in the food processing industry.

Conflict of interest: No

5.0 REFERENCES

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