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Theoretical Formulation of Silicon dioxide Nanoparticles with NanoCalc Android Application as Required in Agro allied Sector.

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***Abstract**: The adoption of nano-silica dioxide particles for the benefits of agro-allied products has attracted some significant interest because of the expanded and improved physicochemical characteristics they offer. Nano-dimension silica particles and their subsidiaries have been acknowledged as a solid approach with an assortment of scientific applications. The simulation and modeling of nano-based chemically active particles is relevant to the understanding of the processes, scaling-up of the experimental conditions, and facility requirements. The modeling that relies on the implementation of physical models with a java-based nanoparticle application was applied to demonstrating a simplified computation of a nano-silica powder and solution for direct applications in agricultural post-harvest activities in particular. Nano-measurement of 100nm with an aqueous volume of 100ml and mass factors of 1 to 10mg declares a direct framework with NanoCalc, the android nanoparticles calculator. It remains a fact that the advantages of nano-silica particles as filler for the medium of preserving and packaging of food products are certainly novel directions nanotechnology is exploiting in the agricultural sector.*

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

1.0 INTRODUCTION

Globally, mankind has been disturbed by the predicament of food product processing and preservation through the induction of toxic synthetic pesticides without consciousness. Notwithstanding, nanotechnology and science mandates in nutrition studies are food security with respect to pathogenic identification, molecular bioactive distribution, long-time preservation, and packaging,[1].

Nanotechnology has recorded notable success in agro-allied development with many fundamental outcomes against the customary agricultural techniques with opposite standpoints [2]. For instance, unique methods have been declared in nano-biosensing development to detect a large level of fertilizers, moisture, pesticides, and other factors related to crop diseases [2]. In this manner, the end user's request for food security has consequently forced researchers to the adoption of nanotechnology in agriculture and nutrition science. Nanomaterial sealing of packaged foodstuffs and nanofiltration in the sieving of pathogenic organisms are typical results [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 with the formulation of synthetic colors, aromatic compositions, and preservatives [3]. Hopefully, these innovations will enable materials that are passive in the aqueous system to be distributed and improve the absorption rate of the encapsulated additives or nutrients [2]. Similarly, food packaging occupies the biggest category of nanotechnology applications in the agrobased industry, as packaging materials that interact directly with food products tend to enhance and retain their quality [4]. Typically, nanoparticles of silica have been applied as agro product preservatives with acute dimensions of about 100 nm in diameter, which induced their interesting characteristics. The drop in particle size directly decreases the specific nanoparticle surface area 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 a covalent bond, as can be naturally found in Quartz. It is white or colorless and is not water or ethanol soluble. It forms the silicate family through reaction with other chemical substituents for categories of technical applications, especially in the food industry. It's applied as an anti-bender, anti-foaming agent, viscosity monitor, desiccant, drink clarifier, and as a medicine and vitamin excipient [5]. Biomaterials, including silica nanopowder in food packaging, protect and preserve foodstuffs by acting as anticoagulants, thickening agents, and antifoaming agents. The hygienic norm with the relevance of nutritional preservatives mandates that they should be used with specified food materials [6]. Another striking benefit of food-grade hydrophilic silica's adhesion is its wettability, which helps to avoid the formation of lumps. This is because

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silicon dust envelops and thus operates as a binder amongst the particles of dust individually. In solution, silicon dioxide offers strong preservation of tinted powders with active transparency [7]. The solution to gel technique offers a novel approach to the progress of advanced materials. This method enables more precise control of all the processes involved in solid-state synthesis. It is simple to make homogeneous multi-component systems; specifically, homogeneous mixed oxides can be formed by blending molecular precursors in solution. (Figure 1) [8].

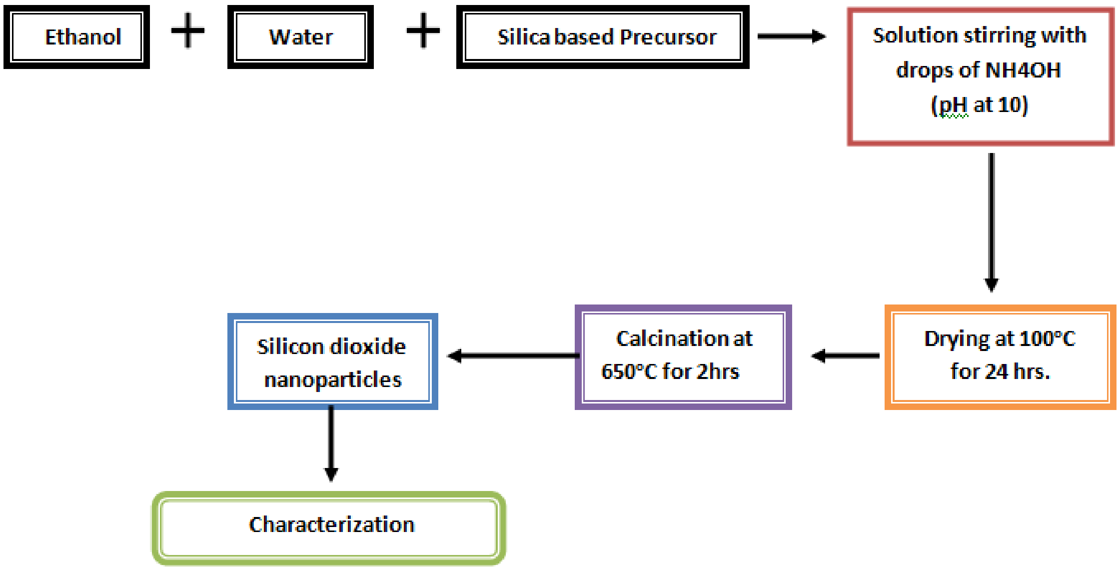

Figure1. Synthetic process of silicon dioxide nanoparticles

Table 1. Recent works on silicon dioxide nanoparticles

Reference	Title	Conclusion
Rahman *et al* ,2012 [9]	Synthesis of Silica Nanoparticles by Sol-Gel: Size-Dependent Properties, Surface Modification, and Applications in Silica-Polymer Nanocomposites—A Review	As silica-polymer nanocomposites, silica nanoparticles are commonly used as fillers through the development of nanoparticles under mild conditions with the typical sol-gel method with a silane-coupling system.
Kao *et al*, 2014 [10]	Synthesis and Characterization of SiO_2 Nanoparticles and Their Efficacy in Chemical Mechanical Polishing Steel Substrate	The research examines the impact of SiO_2 abrasives on polishing performance with chemico-mechanical brushing on a steel substrate. As particle size lowers, the size of nanoparticles drops from 684 to 58 nm, yielding fine particles with a narrow size distribution and improved chemical purity.
Azlina *et al* ,2015 [11]	Synthesis of SiO_2Nanostructures Using Sol-Gel Method	A sol-gel approach was used to successfully produce stable silica nanostructures. .
S. Saravanan and R. S. Dubey, 2020 [12]	Synthesis of SiO_2Nanoparticles by Sol-Gel Method and Their Optical and Structural Properties	Sol-gel nanoparticles having strong excitation peaks at 644.8 nm in the visible range and broad excitation peaks at 359 and 718 nm was produced as the DLS analysis revealed that the particles were 192 nm in size.

Le *et al* 2013 [13]	Synthesis of silica nanoparticles from Vietnamese rice husk by sol–gel method.	The Vietnamese rice husk was effectively converted into a Rice Husk Ash substance. This allows for the low-cost manufacture of silica nanoparticles for a variety of practical applications in the Mekong Delta of Vietnam, including pollution control, nanocomposite materials, and other uses.
This study	Formulation of Silicon dioxide Nanoparticles with NanoCalc Android Application for Application in Agro allied Sector.	The Android nanoparticle application (NanoCalc) was adopted in modeling the synthesis requirements with the silica precursor, generating a relationship between the solution concentration in mole and in grams as y=1.1976x + 0.0013 at R^2 of 1.00.

2.0 Methodology

The synthesis of silicon nanoparticle powder with regards to the diameter, concentration, surface areas, mass, and volume of the nanoparticles with a nanoparticle java-based calculator (NanoCalc) was estimated. The image of the interface inputs is displayed in figure 2 below.

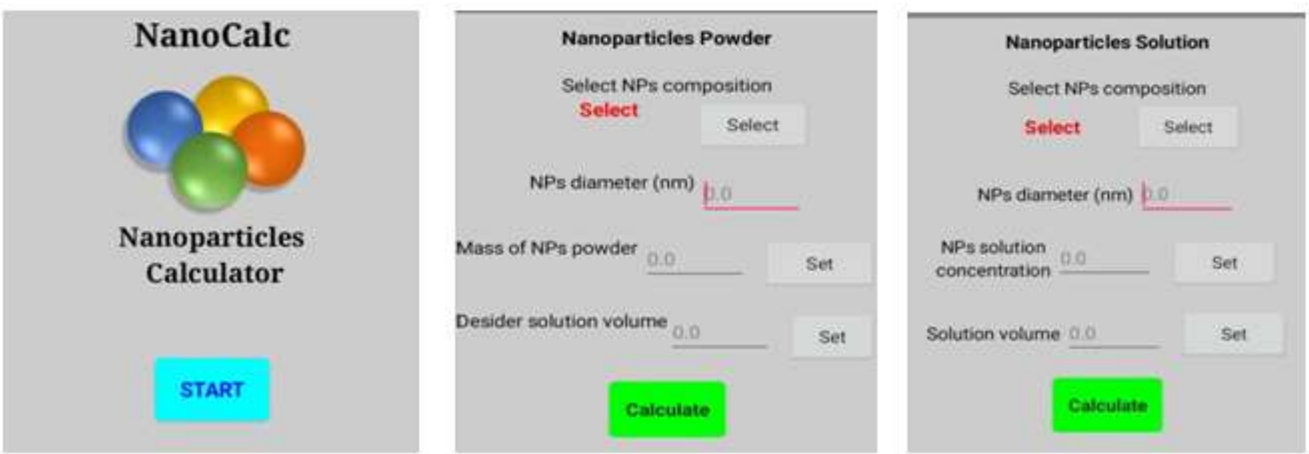

Figure 2. NanoCalc application android interfaces

3.0 Results and Discussion

Table 2. Calculated data output

S-NPs (mg)	Average S-NPs surface area (nm^2) X 10^4	Total S-NPs surface area (nm^2)X 10^{17}	Average S-NPs volume (nm^3) X 10^5	Total S-NPs volume (nm^3) X 10^{18}	Average S-NPs mass (g) X 10^{-15}	S-NPs Conc. (mole) X10^{-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

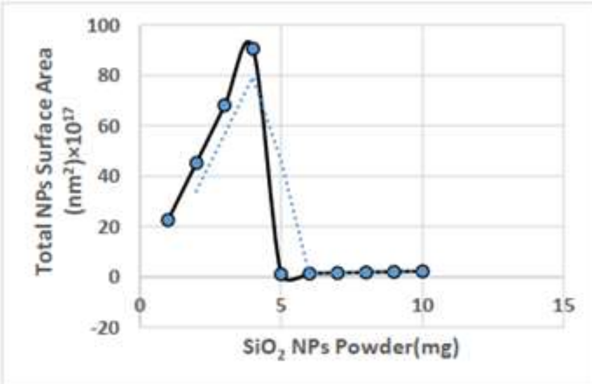

Figure 3. Total S-NPs surface area.

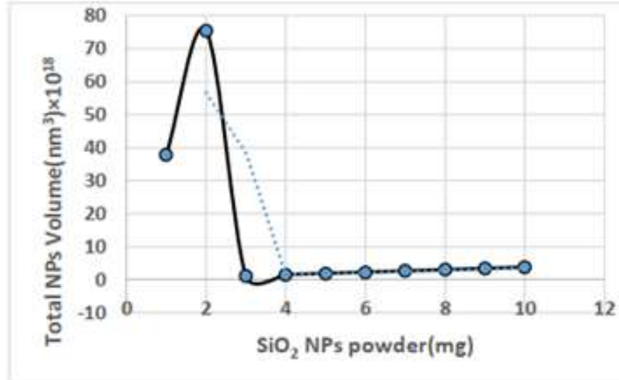

Figure 4. Total S-NPs volume.

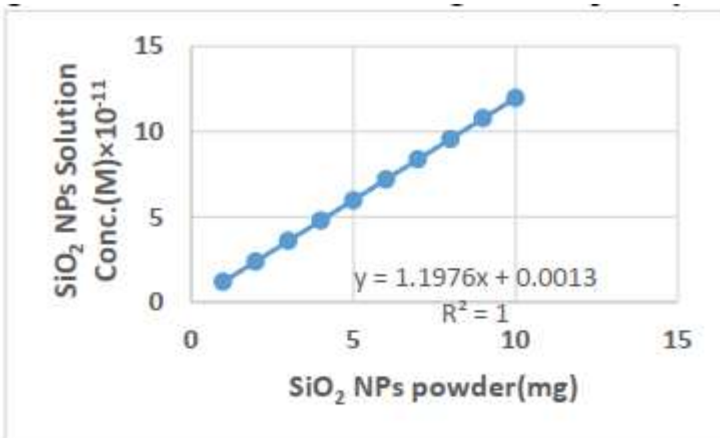

Figure 5. S-NPs solution concentration against the quantity

The outputs of the simulations range from 1 to 10 mg (Table 1), the values that are expected from the silica precursor with regards to their surface areas (Average and total), volume (average and total), mass concentration in gram, in mole, and the room temperature. The interactions of the total nanoparticles surface area with their respective masses in milligram (Figure 3) follows the same pattern as the total volume in nanometer cube (Figure 3), and the masses in milligram (Figure 4). These developments (Figure 3 and 4) clearly declare the similarity between the total surface area and the total volume of the SiO_2 nanoparticles under the same synthetic conditions. The total surface area and the volume are functions of each other in the generation of SiO_2 nanoparticles powder. Figure 5 reflects a linear relationship or model of y=1.1976x+ 0.0013; R^2=1. These are explicitly between the SiO_2 nanoparticles concentration (y) and their concentrations in milligram/gram (x). Furthermore, some distinctive investigations on the synthesis and applications of SiO_2 nanoparticles were stated with their respective assertations on table 2. In general, particle sizes of the nanoparticles are function of their solution's oncentration, the temperature (ambient) and the nature of the silica based precursor. Hence, preparation of silica-based nanoparticles with regards to java based nanoparticle calculator rest on the solution concentration with the expectation of obtaining active nanoparticles as required in agro allied applications.

4.0 CONCLUSION

The background of nanotechnology and science in food science and industry is a recent development in nanostructure production with global security concerns. The profound benefits of silicon nanoparticles were accepted at a summit of professionals from the World Health and United Nations agricultural Organizations. The Administration on Drugs 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 nanomaterials 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 nanomaterials in agro-processing, have been announced by the EFSA and USFDA in 2011 and 2012 respectively. They emphasized the importance of analyzing the interactions between features like particle size and surface properties. No practical advancement has been established globally concerning the safety evaluation of nanomaterials in the food industry. However, the obtainable information on oral protection, metabolism, absorption, excretion, and risk assessment with the ingestion of nanomaterials is scarce and poorly understood. Furthermore, with the knowledge of nanomaterial properties such as particle shape, size, surface structures, distribution, and formation can induce some biological effects, their 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 evaluation needed for production and appropriate utilization of nanomaterials as necessary and required in food management. Future work will aim at experimental validations of this model at laboratory scale.

5.0 ACKNOWLEDGMENT

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