

SYNTHESIS AND CHARACTERIZATION OF NANO SELENIUM AS FEED SUPPLEMENT

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Abstract: Nano-selenium was synthesised by chemical method and characterization of selenium nano particles was carried out by using standard techniques for its use as feed supplement. The nano-selenium produced was fine soft powder in consistency with a yield of 68 per cent. Transmission electron microscope image of nano-selenium revealed well dispersed, spherical shaped selenium nanoparticle with diameter measuring between 30 - 80 nm. The concentration of selenium analysed by energy dispersive X-ray analysis (EDAX) revealed 98.57 ± 0.48 per cent selenium that ensured the purity of the nano- selenium. The observed zeta potential of -22.8mV, revealed the stability of nano-selenium produced in this study.

Keywords: Nano-selenium, TEM, EDAX, Particle size, Zeta potential.

INTRODUCTION

Selenium is a key component of the antioxidant system reducing lipid peroxidation. There is evidence that greater dietary intakes of selenium may have possible health benefits, including a reduction in the risk of cancer. Selenium is an integral part of the enzyme, glutathione peroxidase (GSH-Px) which serves as an antioxidant that helps to control levels of hydrogen peroxide and lipid peroxides. Hence, the supplementation of selenium as an antioxidant is highly essential in the diet which is formulated for enriching the omega-3 fatty acid content in meat to assure its quality and shelf life.

Currently, researchers have demonstrated the increased efficiency of absorption of nano minerals leading to their higher bio availability compared to coarse minerals. A reproducible but simple method of preparation of stable selenium nanoparticles with biomedical application is still a challenge. Both reduction and oxidation techniques can be employed to prepare selenium nanoparticles. The main synthetic approach for preparing selenium nanoparticles is by chemical reduction, employing reducing agent and stabilizer.

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However, the use of stabilizer may hinder the normal utilization of synthesized nanoparticles in biological applications and further stabilizer may have toxic potential due to its chemical nature (Ramamurthy *et al.*, 2013). Hence this experiment was proposed to synthesize and characterize the nano selenium in a reproducible manner to use as a livestock and poultry feed supplement.

MATERIALS AND METHODS

Synthesis of nano-selenium particles

Selenium nanoparticles were synthesized by solution precipitation (Wet Chemical) method as outlined by Kargar Razi *et al.* (2011) in the laboratory of Animal Nutrition, Madras Veterinary College, Chennai. The selenium powder (Sigma Aldrich) was used as a precursor for selenium nano particle synthesis. The dried powder was weighed to study the yield of nano particles and stored in air tight container to prevent the agglomeration and oxidation for further applications. Energy dispersive X-ray analysis (EDAX) was done to analyse four samples for selenium content following the protocol outlined by Russ (1970). The weight per cent of selenium powder and the weight per cent of the synthesized nano-selenium in dried form was taken into account to calculate the yield of nano-selenium by this chemical method of synthesis. In the present study, Transmission Electron Microscopy (TEM) and Particle Size Analyzer (PSA) were used to analyse the properties like morphology, particle size distribution etc.

Characterization of selenium nano particles

a. Transmission Electron Microscopy (TEM)

The size and morphology of the nano selenium was characterised by Transmission electron microscope (Tecani 10, Philips operated under 80 Kv pressure) as per the method of Bisht *et al.* (2005). In this method, one drop of 1 % Phosphotungstic acid was mixed with two drops of aqueous dispersion of nano particles on a para film using a micropipette. A copper grid was placed over the surface of the liquids and left for two minutes. The copper grid was lifted and excess fluid was absorbed using tissue paper. The copper grid was air dried in an incubator at 37° C. The dried copper grid was then examined under a transmission electron microscope. The sample was run in triplicate. The morphology of identified nano-selenium was studied and their size measured.

b. Particle Size Analyzer (PSA)

The particle size and zeta potential of nano-selenium were measured based on the principle of photon correlation spectroscopy using particle size analyser (Horiba SZ-100).

Briefly, eight samples were diluted with MilliQ water, sonicated for two minutes for better dispersion and measurements were conducted at a scattering angle of 90° C and at a temperature of 25° C. The samples were taken in plastic cuvette for particle size analysis and electrode cell for measuring zeta potential. Samples were analysed within two minutes for size measurement and one minute for zeta potential measurement. The nano selenium sample was analysed for its stability by analysing its zeta potential after six months of storage in air tight container.

RESULTS AND DISCUSSION

Synthesis of nano-selenium particles at laboratory level

Nano-selenium was produced by water phase solution method. The concentration of selenium in four samples were analysed by energy dispersive X-ray analysis (EDAX). The result revealed that the sample contained 98.57 ± 0.48 per cent selenium. Kargar Razi *et al.* (2011) produced the sample with 99 per cent selenium content in the nano sample. An elemental composition analysis employing SEM-EDX, Chen *et al.* (2008) showed the presence of 90.96 % selenium content. Based on the observation made to calculate the yield from 0.1 g of selenium coarse particle, 0.068 ± 0.001 g of nano-selenium was recovered. Thus the chemical method followed yielded 68 per cent of nano-selenium synthesis.

Characterization of selenium nano particles

a. Transmission Electron Microscopy (TEM)

The transmission electron microscope photomicrograph of nano-selenium is furnished in Plate 1

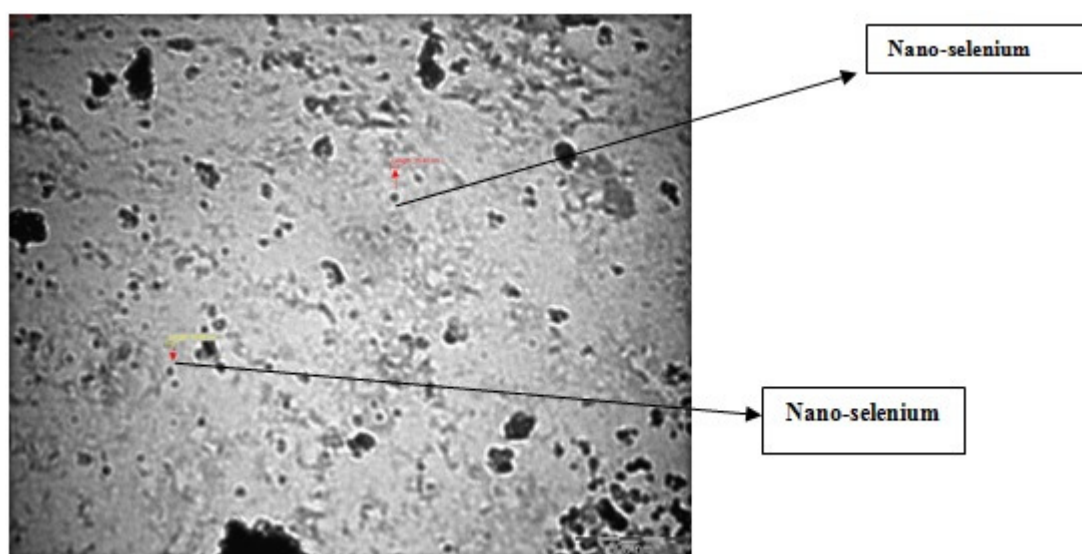


Plate 1. Transmission electron microscope image of nano-selenium size of 30-35 nm and spherical shape

The nano-selenium produced was fine soft powder in consistency. Transmission electron microscope image of nano particle revealed the spherical shaped selenium nanoparticle which was well dispersed and the diameter measured between 30 - 80 nm. Similar finding was reported by Hu *et al.* (2012) that size of nano-selenium ranged between 20 - 80 nm. Chen *et al.* (2008) synthesised spherical shaped nano selenium of 44 - 92 nm diameters. Sasidharan and Balakrishnaraja (2014) produced sphere shaped 50 - 500 nm sized nano-selenium in a biological system with *lactobacillus* sp. by fermentation technology.

b. Particle size Analyzer (PSA)

The dynamic light scattering spectrum indicated the range of 74 to 76 nm particles present in the sample which was similar to TEM images. This range clearly indicated uniform distribution of particles in the sample. The synthesized nano-selenium showed very high negative zeta potential of -22.8mv. Generally, nanoparticles with very high positive or negative zeta potential have electrostatic repulsion with one another, thus preventing cluster formation. The sample was observed to be stable for a period of six months without any cluster formation. These results are in agreement with Karnik *et al.* (2008) who produced nano-selenium with a zeta potential of -28 mV.

This experiment revealed that spherical shaped, pure nano-selenium particles of size ranging between 30-80 nm could be produced by wet chemical method at laboratory level. The synthesized nano-selenium particles had a stable zeta potential of -22.8mV. Since, the synthesized nano-selenium had all the requisite characteristics of nano particles, it may be used as livestock and poultry feed supplement to replace its coarse particle source to increase bioavailability and effectiveness.

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