Synthesis and Characterization of Nano-Strontium Oxide(SrO) using Erzin Cimin Grape (*Vitis Vinifera*, Cimin)

.

ABSTRACT

Aims: Strontium oxide (SrO) synthesis is very striking due to its applications in electrodes for gas sensors, lithium-ion batteries, solar cells, doped dye-sensitive solar cells, transistors, catalyst supports, super capacitors and semiconductors. It is intended to synthesize using a new method for SrO nanoparticles because it is used in many areas mentioned above.
Study design: Synthesis of SrO nanoparticles(NPs) was planned by bio-reduction method using the plant extract of Erzincan Cimin grape (*Vitis vinifera*, Cimin) water extract.
Place and Duration of Study: The experimental steps of the study were carried out in the laboratories of Atatürk University Erzurum Vocational School Department of Chemical and Chemical Processing Technologies.
Methodology: In this study, the synthesis of SrO NPs was made by using Erzincan Cimin grape (*Vitis vinifera*, Cimin) water extract. Biosynthesis medium containing 0.1 M $Sr(NO_3)_2$ was added to Cimin grape extract to synthesize SrO NPs.
Results: The structural characterization of the SrO NPs obtained as a result of the reaction was analyzed using SEM, EDAX and FTIR techniques. Using the X-ray diffraction pattern in the study, the mean particle size (28.6 nm) was calculated. With the help of SEM analysis, it was understood that particles having a porous nanostructure of 20-50 nm were synthesized. It was determined that SrO nanoparticles were absorbed at 203 nm using UV spectrophotometer. At the end of the experiments, it was observed that the maximum synthesis rate was reached at 90 minutes, at 40^oC and pH 8.
Conclusion: Due to the physical and chemical properties of the new nanomaterial synthesized, it is assumed that it will find applications in many different areas.

Key Words: *Erzincan Cimin Grape (Vitis Vinifera, Cimin), Strontium oxide NP, Green synthesis*

1. INTRODUCTION

The developments in the synthesis approaches of nanomaterials are distinguished by the acquisition of new chemical and physical properties. Today, with the use of green synthesis reactions, it has gained significant momentum in the synthesis of many metal oxide nanoparticles. The synthesis of transition metal oxide nanoparticles such as strontium oxide (SrO) is emphasized due to the structural diversity and spectrum of applications. SrO NPs have been investigated for their promising applications of gas sensors, lithium-ion batteries, solar cells, doped dye-sensitive solar cells, transistors, catalyst supports, supercapacitors and electrodes for semiconductors[1].Some studies reported the sol-gel synthesis method of SrO NPs and investigated the optical and thermal properties of nanoparticles. In another study, Nemade and Waghuley reported that they produced strontium oxide nanoparticles using a one-step chemical precipitation method using [2]. In all of these synthetic methods, extreme conditions (high temperature, organic solvents, high-precision precursors, toxic reducing agents, and special atmospheric media) are used and there are many disadvantages such as requiring a few steps to perform an experiment. In addition, many of the chemical reducing agents and solvents used in these methods bear biological risk and are harmful to the environment. There is very little literature on the synthesis of SrO NPs in this way, and these methods have their own limitations. To overcome this disadvantage, many researchers nowadays use various nanoparticles, such as Pomegranate (*Punica granatum*), Basil (*Ocimum sanctum*), Papaya (*Carica papaya*) and Cabbage (*Brassica oleracea*). A great interest has been shown for the development of novel and simple approaches to nanoparticle synthesis using plant materials as reducing agents. To improve the properties of nanoparticles is an important step on the way to the synthesis of nanomaterials that impart different morphology and nano size. In addition, under moderate conditions, green chemical synthesis pathway for the preparation of SrO NPs has come to the fore with an efficient approach such as room temperature and neutral pH. Researchers have begun to find and develop new, economic and environmental methods for reasons such as environmental pollution factors and cost increase in the synthesis of nanoparticles.

Therefore, Erzincan Cimin grapes (*Vitis vinifera*, Cimin) were used as reducing agents in the synthesis of SrO NPs. It is a variety of black grape grown in the region of Erzincan in Turkey. In the past, the grape and its product were known for its use in the treatment of diseases among the public. Today, Erzincan Cimin grapes are known to be used in food and health sector [3]. It has been thought that it can be used as a reducing and stabilizing agent in green Nano synthesis due to the presence of important components such as sugar derivatives, alkaloids and terpenoids in the extract of grapes [5]. As a result of the investigations, we have not seen any other research in which the Erzincan Cimin grape was used and the SrO NPs were synthesized. Therefore, it is aimed to use Cimin grape to synthesize nanoparticle synthesis in more efficient, economical and moderate conditions and to characterize the synthesized SrO NPs.

2. MATERIAL AND METHODS

2.1. Chemical and reagents

An endemic type of Cimin grape (*Vitisvinifera cv.* Cimin) was obtained from Cimin district of Erzincan province in September, 2017. $Sr(NO_3)_2$, Sodium acetate ($NaCH_3COO$), Tris ($(HOCH_2)_3CNH_2$), Sodium carbonate (Na_2CO_3), Sodium hydroxide (NaOH), Hydrochloric acid (HCl) were purchased from Sigma-Aldrich GmbH, (Sternhe I Germany). The other chemicals were obtained from Merck. Deionized water was used to prepare all solutions. All the materials to be included in the experiments were disinfected in the oven and sterilized to ensure a clean environment.

2.2 Preparation of the reaction medium;

The grapes were washed with pure water after the Cimin grape (*Vitisvinifera cv.* Cimin) was obtained from Erzincan. It was then rinsed, dried and stored in a freezer at -20 ° C until working. The water extract of the grapes was prepared and used as a green synthesis reaction medium. In a simple procedure in the presence of Cimin grape (*Vitisvinifera cv.* Cimin) 100 grams of grapes was taken and 250 ml of pure water was added and then blended in the blender forming a homogeneous mixture prepared for 30 minutes at 300 rpm. The homogenate was then filtered through a filter paper, then the filtrate was centrifuged at 3000 xg to remove heterogeneous moieties. The resulting Cimin grape (*Vitisvinifera cv.* Cimin) water extract was used as the reaction medium for synthesis [6].

2.3. Green synthesis of SrO NPs;

The prepared 50 mL reaction mixture was added carefully to the solution prepared with the water-soluble salt of 500 mL of 0.1 M Sr metal, respectively. (Figure 1) With the help of magnetic stirrer, the reaction mixture was monitored by spectrophotometer for 72 hours, keeping the green synthesis reaction medium at 300 rpm under normal atmospheric pressure and room conditions. For this purpose, the conversion of the charged metals in the strontium solutions to the metallic nano SrO NPs was first screened between 200-1000 nm using the spectrophotometer and the wavelength of the SrO NPs was determined at 203 nm. [2]. This wavelength was used in the subsequent optimization process. The time, pH, temperature and metal ion concentration parameters were determined separately to perform the optimization [2].

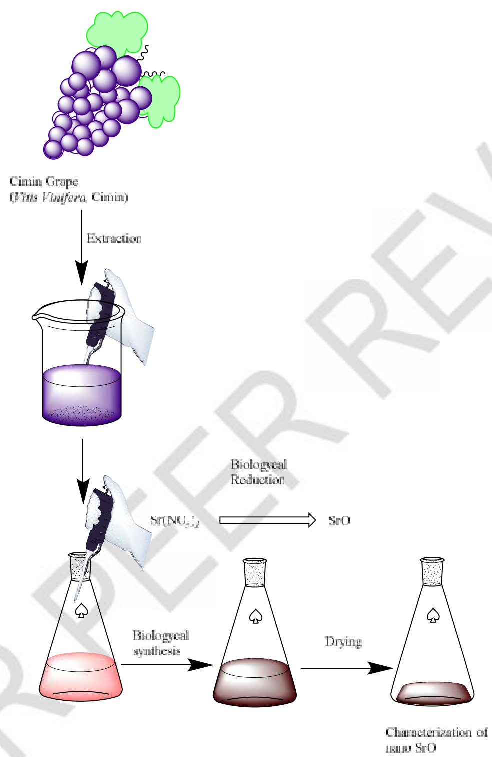

Figure 1. Synthesis Nano Strontium Oxide (SrO) by Erzincan Cimin Grape (*Vitis Vinifera,* Cimin)

2.3.1. Interaction time

For this purpose, the reaction medium prepared with $Sr(NO)_3$ was taken with a 3-minute interval and the spectrophotometer was monitored for 240 minutes by measuring the absorbance (203 nm) against the blunt solution, and it was determined that the time of formation of the SrO NPs was highest.

2.3.2. Optimum pH

For the synthesis of SrO NPs, it was investigated which pH was more efficient by using different buffers solutions. For this purpose, the reaction medium was formed using phosphate buffer for pH: 2-3, acetate buffer for pH: 4-6, phosphate buffer for pH: 7-8 and carbonate buffer for pH: 9-11, and the changes in absorbance at 203 nm was measured by spectrophotometer.

2.3.3. Optimum temperature

In order to determine the temperature at which the SrO NPs are synthesized more effectively, reactions were made at 10-90 ^{o}C to determine the optimum temperature by analyzing the solutions taken from the reaction medium against the blind solutions.

2.3.4. Optimum Metal Ion Concentration

Different concentrations of solutions (0.05M, 0.1M, 3M, 5M and 7M) were prepared for SrO NPs and the effect of metal ion concentration on the reaction was determined by spectrophotometer (203 nm).After all conditions were optimized, the obtained SrO NPs were collected, dried and then characterized.

2.4. Characterization of SrO NPs

The synthesized SrO nanoparticles were characterized by a UV-VIS spectrophotometer (Epoch Nanodrop UV-VIS spectrophotometer), scanning in the 200-1000 nm range. The topography of SrO nanoparticles was performed by SEM (Scanning Electron Microscope) analysis. EDAX and FTIR chromatography were used for further characterization of SrO nanoparticles[8,9].

3. RESULTS AND DISCUSSION

Strontium is a compound having thermal, electrical and electro catalytic activity. It has also been used in dental and dental applications[1]. Strontium (Sr) has been reported to be one of the important trace elements that increases the strength of bones in the human body and prevents caries[10]. In previous studies for the synthesis of SrO NPs, various chemical and physical methods have been performed, for example, sol-gel, co-precipitation, hydrothermal and spray pyrolysis. Conventional hydrothermal methods have also been used for the synthesis of SrO nanoparticles. In particular, by means of microwave hydrothermal synthesis, high temperature heat treatment which can lead to particle growth and agglomeration can be avoided. However, the use of large amounts of strontium precursors and low yield are two major disadvantages of the method previously used [11]. In another study, it has been reported that Strontium oxide (SrO) NPs is synthesized by hydrolysis of single source molecular precursor $SrCl_2 \cdot 6H_2O$ with potassium hydroxide. The structure, morphology and properties of the particles were characterized and XRD, TEM, Raman and UV-VIS spectroscopy were used in this study.

Using the X-ray diffraction model in our study, the mean particle size (28.6 nm) was calculated and FT-IR chromatography techniques were used for the characterization of the nanoparticles. The size and purity of the nanoparticle were improved by optimizing the synthesis curves (pH, temperature, reaction time, etc.). As a result of the research, the strontium oxide nanoparticles were synthesized with a green synthesis method by using Erzincan Cimin grape. The reactions were carried out at 203 nm using a UV spectrophotometer. At the end of the experiments carried out for the optimization of the method, the maximum synthesis rate at 40 ^{o}C and pH 8 was reached in 90 minutes. After optimizing the reaction, the characterization of the obtained nanoparticles was performed and with the aid of SEM analysis, it was understood that the particles having a porous nanostructure of 20-50 nm size were synthesized as shown in Figure 2.

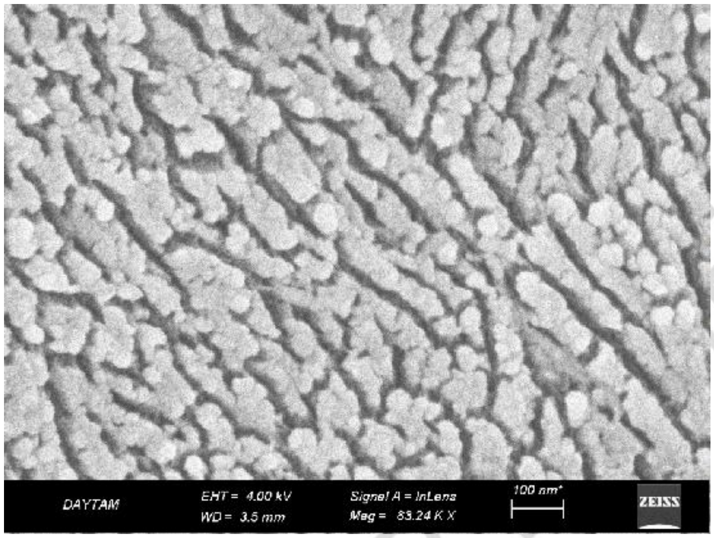

Figure 2. SEM chromatography of strontium oxide nanoparticles

As a result of EDAX analysis with SEM chromatography, the obtained data and chromatogram were found to support the formation and structure of SrO nanoparticles and are shown in Figure 3 below.

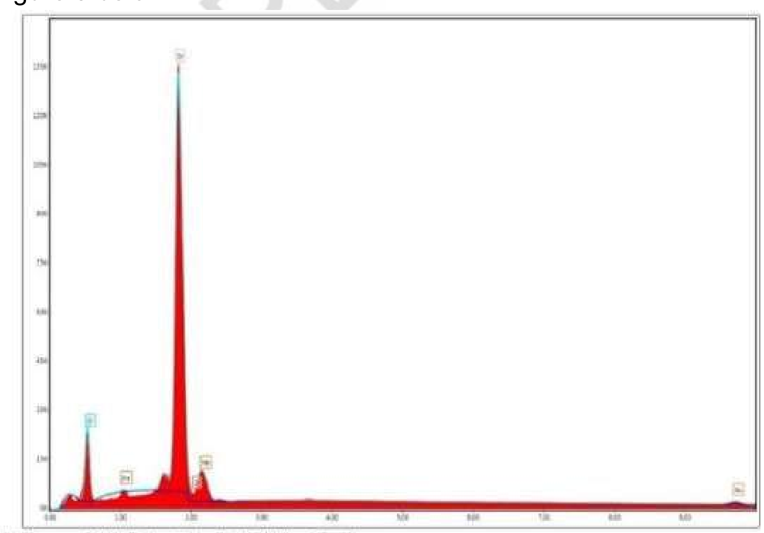

Figure 3. SEM-EDAX chromatographic result

As a result of the interaction of strontium with the organic phase in another synthesis, characteristic nanostronium peaks were found at 1083 and 1317 cm^{-1}. [11] The structure of nanoparticles has been studied by using FTIR analysis. As a result of our experiments 1019 cm-1 and 1301 cm-1 in the characteristic SrO NP 's were encountered in the organic peak interaction peaks in figure 4.

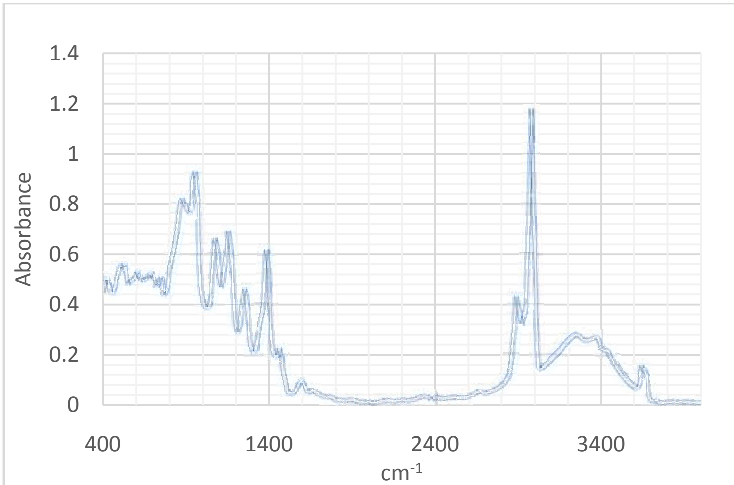

Figure 4. FTIR spectrum of SrO nanoparticles

4. CONCLUSION

Today, due to cost and environmentally friendly approaches, the use of green chemical reactions has gained significant momentum in the synthesis of a large number of metal oxides (NPs). So far, various chemical methods for SrO NP synthesis have been given priority, for example; sol-gel, co-precipitation, hydrothermal and spray pyrolysis. For this reason, the synthesis of nanoparticles (NPs) of SrO with widespread use is an important and interesting research topic. According to the results obtained from SEM, XRD and FTIR analyzes, nano-sized strontium oxide particles can be synthesized by the method used. It is concluded that these synthesized nanoparticles can be used because of the advantages gained in the production approach in many areas by the production of nanomaterial.

REFERENCES

1. Olga AM, Canfield NL, Stevenson JW. Thermal, Electrical, and Electrocatalytical Properties of Lanthanum-Doped Strontium Titanate. Solid State Ionics. 2002;149 (21): 11.
2. Nemade KR, Waghuley SA, UV–VIS Spectroscopic Study of One Pot Synthesized Strontium Oxide Quantum Dots. Results in Physics. 2013;3:52–54.
3. Nadaroglu H, Ince S, Gungor AA. Green Synthesis of Gold Nanoparticles Using Quail Egg Yolk and Investigation of Potential Application Areas. Green Processing and Synthesis. 2017; 6(1):43-48
4. Fan JD, Lou H, Yu W, Ren D, Ma B, Ji H, Novel Flavanol Derivatives from Grape Seed.Lett, Tetrahedron 2004; 45: 3163–66.
5. Apsana G, George PP, Devanna N, Yuvasravana R. Biomimetic Synthesis and Antibacterial Properties of Strontium Oxide Nanoparticles Using Ocimum Sanctum Leaf Extract. Asian J Pharm Clin Res. 2018;11:384–389.

6. Nadaroglu H, Gungor A A, Ince S, Babagil A.Green Synthesis and Characterisation of Platinum Nanoparticles Using Quail Egg Yolk. Spectrochimica Acta –Part A: Molecular and Biomolecular Spectroscopy. 2017;172(5):43-47.
7. Lin Y, Zhuoru Y, Jiang C, Lianshi W. Synthesis, Characterization and Antibacterial Property of Strontium Half and Totally Substituted Hydroxyapatite Nanoparticles.Journal Wuhan University of Technology, Materials Science Edition 2008.
8. Karaduman, I, Güngör A A, Nadaroğlu H, Altundaş A, Acar S. Green Synthesis of γ-Fe_3O_4 Nanoparticles for Methane Gas Sensing. Journal of Materials Science: Materials in Electronics 2017; 28(21) 16094–105.
9. Nadaroglu H, Onem H, Gungor AA. Green Synthesis of Ce2O3 NPs and Determination of Its Antioxidant Activity.IET Nanobiotechnology. 2017;11(4):411-419
10. Simões AZ, Moura F, Onofre TB, Ramirez MA, Varela JA, Longo E, Microwave-Hydrothermal Synthesis of Barium Strontium Titanate Nanoparticles. J of Alloys and Compd. 2010; 508: 620-624.
11. Deepthi S, Amna A. Gafoor A A. Sivashanmugam SVN, Jayakumar R. Nanostrontium Ranelate Incorporated Injectable Hydrogel Enhanced Matrix Production Supporting Chondrogenesis: In Vitro. Journal of Materials Chemistry B. 2016; 4(23): 4092-4103.