# SYNTHESIS OF STABLE SELENIUM NANOPARTICLES IN WATHER SOLUTION OF SODIUM-CARBOXYMETHYLCELLULOSE FOR THE CANCER TREATMENT

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**Abstract:** In this study, a 2% aqueous solution of purified sodium carboxymethylcellulose (Na-CMC) with degree of polymerization 1015 and degree of substation 0.85 and sodium selenite ($Na_2SeO_3$) salt were used for the synthesis of selenium nanoparticles. Chemical structure of the polymer-metal composite $[Se^0_n(C_5H_7O_4\text{-}CH_2OCH_2COO)^-_m]$ and chemical bonds formed between selenium nanoparticles and Na-CMC molecules were studied by fourier transform infrared (FTIR) spectroscopy.

**Key words:** sodium - carboxymethylcellulose, selenium nanoparticles, chemical reduction.

Recent progress in cancer nanotechnology raises exciting opportunities for specific drug delivery. Nanoparticles, particularly in the size range from 10 nm to 100 nm, are emerging as a class of therapeutics for cancer treatment. Especially metallic selenium nanoparticles (SeNPs) constitute one such step towards the more effective cancer treatment strategies [1]. SeNPs are particularly advantageous in treatment of cancer due to the accuracy with which their shape, size, charge, and surface modification can be controlled [2]. In recent ears, there has been increasing interest in the trace element selenium, which is part of the body's antioxidant defense system. Polymer contained SeNPs, unlike anticancer drugs, are able to have a prolonged effect [3] SeNPs is an important trace element in the human body and participates in more than 30 types of biologically active processes in the body. Selenium element destroys active enzymes, antioxidants, nucleic acids, lipids, free radicals generated in the body and prevents and cures tumor diseases [4].

The relevance of this study is also determined by the urgent need for public health in new highly effective and low-toxic drugs that have an antitumor effect based on selenium nanoparticles. Due to the high prevalence of oncological diseases, there is a high demand of the domestic chemical and pharmaceutical industry for the production of new drugs using nanochemistry, nanopharmacology and nanotechnology.

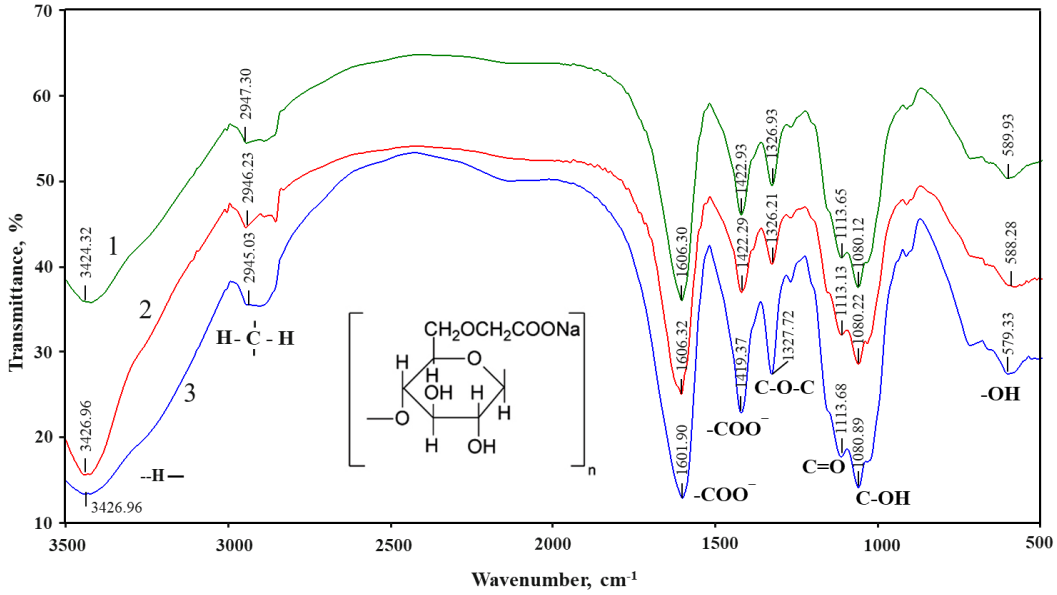
The purpose of this work is to synthesis of polymer-metal composite $[Se^0_n(C_5H_7O_4\text{-}CH_2OCH_2COO)^-_m]$ of SeNPs by chemical reduction in a solution of purified Na-CMC and study its physicochemical properties.

In this study, aqueous solutions of sodium selenite ($Na_2SeO_3$) with a concentration of 0.1 M were used to synthesize SeNPs from selenite ions ($SeO_3^{2-}$). A 2% aqueous solution (pH=7.78) of purified Na-CMC was chosen as the stabilizing polymer matrix. Chemical reduction of selenite ions in the solution of Na-CMC to SeNPs was carried out at 60°C by adding 0.1 M aqueous solution of ascorbic acid ($C_6H_8O_6$). In the presence of $C_6H_8O_6$ in 2% aqueous solution of the selected purified Na-CMC sample, the $SeO_3^{2-}$ of the $Na_2SeO_3$ salt is returned to the zero-valent (0) selenium element $Se^0$ (reaction 1).

$$\mathbf{Na_2SeO_3 + 2C_6H_8O_6 = 2C_6H_6O_6 + Se + H_2O + 2NaOH} \qquad (1)$$

Selenium atoms in solution have positively charged and negatively charged dipoles as a result of electron and atomic polarization. In electron polarization, the positively charged nucleus of the selenium atom and the negatively charged outer electrons are placed on opposite sides under the influence of polar molecules and polar functional groups. Atomic polarization results in the formation of polar SeNPs with positively charged and negatively charged dipoles. The positive dipoles of the formed SeNPs form a dipole bond with the strong negative dipoles of the carboxylate ($-COO^-$) and hydroxyl ($-OH^-$) groups, forming $[Se^0_n(C_5H_7O_4\text{-}CH_2OCH_2COO)^-_m]$ and ensuring the stability of SeNPs.

In order to determine the changes in the functional groups of the Na-CMC macromolecule containing SeNPs and the structure of the pyolimer-metal composite, FTIR-spectroscopy studies were carried out on the powder samples of Na-CMC, $SeO_3^{2-}$-CMC and [$Se^0_n(C_5H_7O_4$-$CH_2OCH_2COO)^-_m$] solutions (Fig. 1.).




*1)Na-CMC, 2) $SeO_3^{2-}$ CMC, 3) [$Se^0_n(C_5H_7O_4$-$CH_2OCH_2COO)^-_m$]*

**Fig. 1.** The results of FTIR-spectroscopy studies of films obtained from solutions of Na-CMC contained SeNPs.

The development of a link between carboxylate and SeNPs is indicated by the change of the symmetrical stretching vibrations of carboxylate groups (–$COO^-$) from 1606 $cm^{-1}$ in Na-CMC to 1601 $cm^{-1}$ in SeNPs–CMC, as shown in Figure 1. The bonds appearing at 1422 $cm^{-1}$ to 1419 $cm^{-1}$ were ascribed to the lengthening of the C-H (Fig. 1. Curve 1-3).

These changes can be explained by the attraction of the negatively polarized -$COO^-$ group toward the positively polarized SeNPs as the bond length increases and the wavenumber decreases with increasing bond length. In the spectra typical of simple ether (C-O-C), carbonyl (C=O) and hydroxyl (–OH) groups, the wavenumbers were 1326, 1113 and 1080 $cm^{-1}$, respectively, and no differences were observed between these functional groups.

In conclusion, a polymer-metal composite containing [$Se^0_n(C_5H_7O_4$-$CH_2OCH_2COO)^-_m$] was synthesized by chemical reduction method from $Na_2SeO_3$ salt in the presence of $C_6H_8O_6$ in purified Na-CMC solutions under laboratory conditions.

New dipole-dipole bonds formed between asymmetric and symmetric hydroxyl groups and SeNPs in the synthesized stable polymer-metal composite were detected in the 1601-1419 $cm^{-1}$ range of FTIR spectra.

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