

# **Nanomedicine-Based Combination Anti-Cancer Therapy between Nucleic Acids and Anti-Cancer Nano Drugs in Covalent Nano Drugs Delivery Systems for Selective Imaging and Treatment of Human Brain Tumors Using Hyaluronic Acid, Alguronic Acid and Sodium Hyaluronate as Anti-Cancer Nano Drugs and Nucleic Acids Delivery under Synchrotron Radiation**

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## **EDITORIAL**

Nanomedicine-based combination anti-cancer therapy between nucleic acids and anti-cancer Nano drugs in covalent Nano drugs delivery systems for selective imaging and treatment of human brain tumors using hyaluronic acid, alguronic acid and sodium hyaluronate (Figures 1 and 2) as anti-cancer Nano drugs and nucleic acids delivery under synchrotron radiation has been explored as an alternative approach to the synthesis of electronically and optically active polymers with several advantages<sup>1-33</sup>. Horseradish Peroxidase (HRP) catalyzes the decomposition of Hydrogen peroxide ( $H_2O_2$ ) at the expense of aromatic proton donors. Horseradish Peroxidase (HRP) is a Fe containing porphyrin-type structure. In previous works, we synthesized hyaluronic acid, alguronic acid and sodium hyaluronate, enzymatically<sup>1-33</sup>. The results of enzymatic polymerization were different from chemical and electrochemical polymerization

of hyaluronic acid, alguronic acid and sodium hyaluronate that reported previously<sup>1-33</sup>. In this editorial, we reported the enzymatic copolymerization of aniline and hyaluronic acid, alguronic acid and sodium hyaluronate with Horseradish Peroxidase (HRP) in the presence of Sulfonated Polystyrene (SPS) as a template. The properties of synthesized copolymer were different from chemical ones. The copolymerization of monomers system gave rise to a lower electrochromic response with enhanced electrochemical stability. The reaction was carried out in mild conditions, aqueous 0.5 M sodium phosphate buffer (pH=4.4). The polymerization was initiated by Hydrogen peroxide ( $H_2O_2$ ) and the progress of the reactions was monitored, spectroscopically. A violet solution was formed immediately by adding Hydrogen peroxide ( $H_2O_2$ ). Different results were obtained while changing in molar ratio of two monomers. The UV-Vis spectrum of copolymer

is almost similar to enzymatic synthesized hyaluronic acid, algonuronic acid and sodium hyaluronate.  $^1\text{H}$ NMR,  $^{13}\text{C}$ NMR,  $^{31}\text{P}$ NMR, Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR), FT-Raman, UV-Vis and HR Mass spectroscopic methods confirm that aniline and hyaluronic acid, algonuronic acid and sodium hyaluronate are presence in structure of synthesized copolymer. Cyclic voltamogram of synthesized poly (aniline-co-o-hyaluronic acid/algonuronic acid/sodium hyaluronate) show two sets of redox peaks and indicated convenient electroactivity for this copolymer (Figures 1 and 2).

Polymer nanocomposites consist of polymers loaded with high-surface-area reinforcing fillers. Among these nanocomposites, hyaluronic acid, algonuronic acid and sodium hyaluronate with conducting polymers have been proposed for different applications. Polyaniline (PANI) is one of the most studied electrically conducting polymers because of its good processability, environmental stability, and potential in the catalysis field, biosensors, batteries and electronic technology. We have reported polymerization of aniline on hyaluronic acid, algonuronic acid and sodium hyaluronate nanosheet particles, previously<sup>1-33</sup>. Polyaniline (PANI)/hyaluronic acid/algonuronic acid/sodium hyaluronate have previously been synthesized chemically and electrochemically<sup>1-33</sup>. These methods need harsh conditions such as low temperature and high acidity. In this editorial, we have reported in-situ enzymatic synthesis of Polyaniline (PANI) on hyaluronic acid, algonuronic acid and sodium hyaluronate nanosheet particles in the presence of sulfonated polystyrene as a polyanionic template. The polymerization was catalyzed by Horseradish Peroxidase (HRP) in room temperature and aqueous medium. Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) was used as an oxidant.  $^1\text{H}$ NMR,  $^{13}\text{C}$ NMR,  $^{31}\text{P}$ NMR, Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR), FT-Raman, UV-Vis and HR Mass spectra and also Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Dynamic Light Scattering (DLS), Pulsed Laser Deposition (PLD), X-Ray Diffraction (XRD) and Energy-Dispersive X-Ray Spectroscopy (EDX) images indicate that Polyaniline (PANI)/hyaluronic acid/algonuronic acid/sodium hyaluronate nanocomposite was formed. Furthermore,

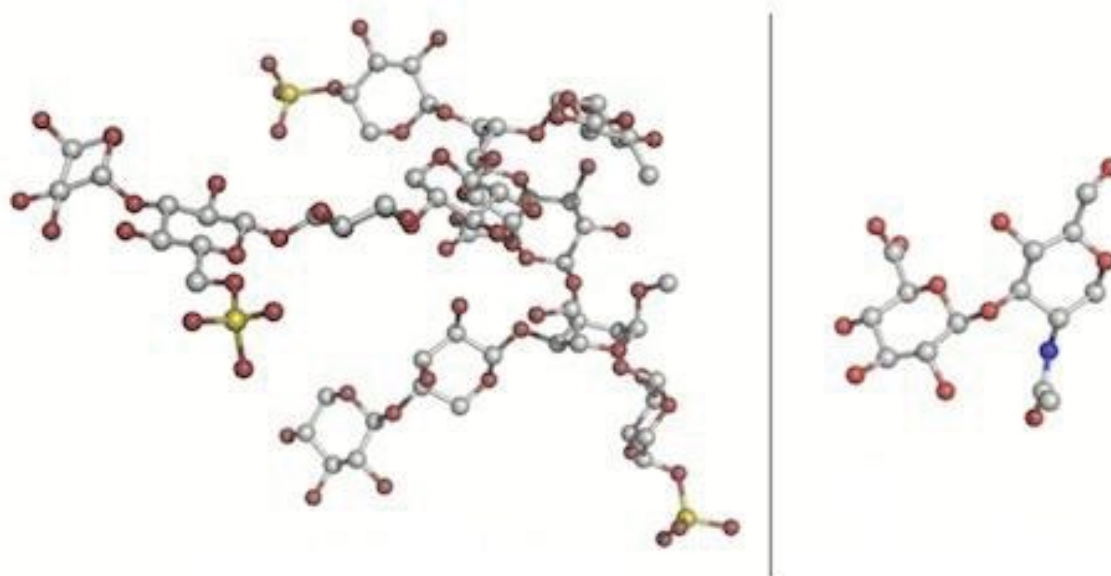
Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Dynamic Light Scattering (DLS), Pulsed Laser Deposition (PLD), X-Ray Diffraction (XRD) and Energy-Dispersive X-Ray Spectroscopy (EDX) images confirmed the nanostructure of the composite. Cyclic voltamograms showed that Polyaniline (PANI)/hyaluronic acid/algonuronic acid/sodium hyaluronate nanocomposite has good electroactivity in nanomedicine-based combination anti-cancer therapy between nucleic acids and anti-cancer Nano drugs in covalent Nano drugs delivery systems for selective imaging and treatment of human brain tumors using hyaluronic acid, algonuronic acid and sodium hyaluronate as anti-cancer Nano drugs and nucleic acids delivery under synchrotron radiation.

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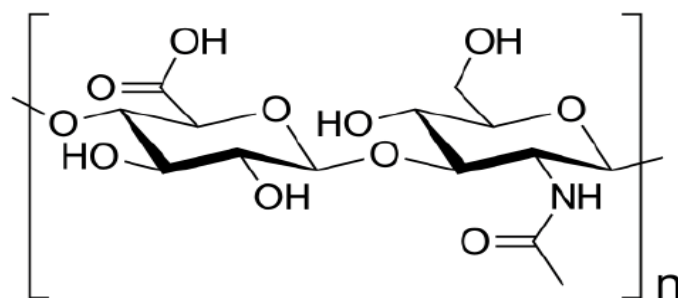
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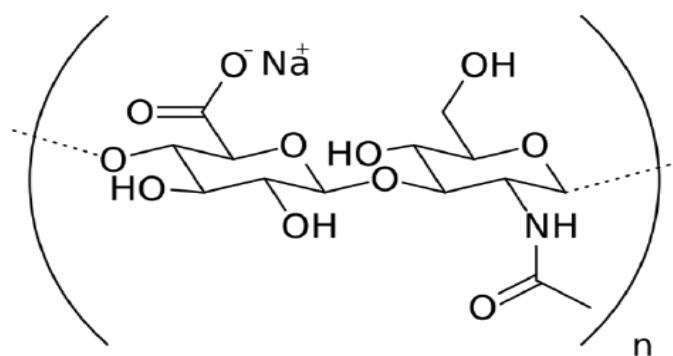
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**Figure 1.** Molecular structures of algonuronic acid (left) and hyaluronic acid (right)<sup>1-33</sup>



(a)



(b)

**Figure 2.** Chemical structures of (a) hyaluronic acid and (b) sodium hyaluronate<sup>1-33</sup>