SYNTHESIS BY GAMMA RADIATION AND CHARACTERIZATION OF POLY(VINYLPYRROLIDONE) NANOGEL.

Ges A.[a], Viltres H.[a,d], Ponce L.[b], García L.[c], Rapado M.[c], Aguilera Y.[a] ages@instec.cu, yuri@instec.cu

a Higher Institute of Technologies and Applied Sciences (InSTEC), La Habana, Cuba.
b Biology Faculty of Havana University, La Habana, Cuba.
c Nuclear Development and Technological Applications Centre (CEADEN), La Habana, Cuba.
d Center of Research in Applied Science and Technology Advanced, Legaria-Unit, Polytechnic National Institute, Ciudad de Mexico, Mexico.

International Conference on Applications of Radiation Science and Technology (ICARST 2017)
24 to 28 April 2017, Vienna, Austria

INTRODUCTION

Nanogels—particles of polymer gels having the dimensions in the order of nanometers—are gaining attention for their wide application as biomaterials[1-4]. Mainly, the nanogels are promising novel pharmaceutical carriers for small biologically active agents, biomacromolecules and can be chemically modified to incorporate various ligands for targeted drug delivery. This important factor has stimulated research on dissimilar science field such as nanotechnology and biotechnology, polymer and materials sciences, biochemistry, radiation chemistry and pharmaceutical sciences. A multitude of techniques have been described for the synthesis of this nanomaterial from polymers. However, the use of ionizing radiation (γ, e-) has demonstrated to be especially suitable for obtaining polymeric nanogels with a high degree of purity for biomedical applications[1,5,6], although the gamma radiation has not been widely utilized for these purposes. The synthesis of PVP (polyvynilpyrrolidone) nanogels by gamma irradiation, for their evaluation as potential pharmaceutical carriers was the aim of this research. Also, the PVP concentration influence on nanogels synthesis was evaluated.

METHODS AND MATERIALS

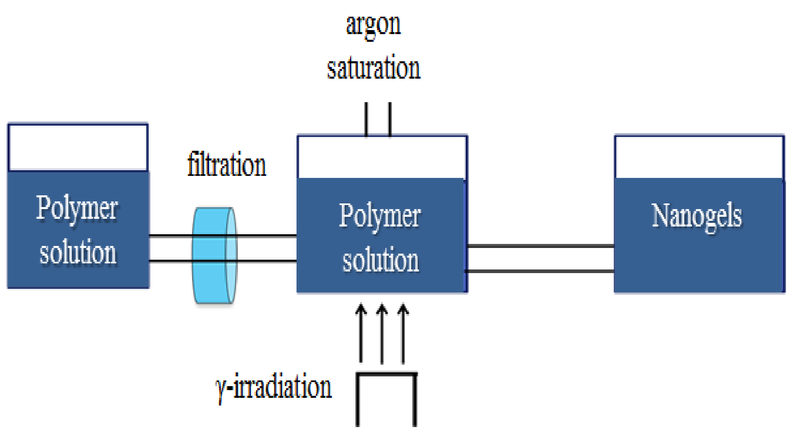

Fig. 1 Scheme of the experimental set-up.

Table 1. Experimental Conditions.

Experimental Parameters		
PVP Concentration (%)	Dose (kGy)	Temperature (^{0}C)
0.1-0.25%	3-22	25
Characterization Techniques		
Viscosimetry		
Light Scattering(DLS)		
Spectroscopy (ATR)		
Electron Microscopy (TEM and SEM)		
Cytotoxicity Assays: Test MTT		
Immunological Response: TEM on monocytes		

CONCLUSIONS

- Nano and micro gel particles of polyvynilpyrrolidone were synthesized by gamma radiation.
- By using both light scattering and TEM the PVP nanogels were measured, these showed a size distribution of 50.10 nm (PVP 0.1 % nanogels), in spite of the increase of *Mw*, indicating some contribution of intermolecular recombination.
- The PVP concentration has a strongly influence on crosslinking reactions at constant dose value for obtained product and lower influence on morphology and chemical structure.
- The nanogels has an elliptical shape forming nanoparticles in solution and they tend to agglomerate in the solid state.
- The biological assays suggest that in the near future, they could have an extensive field of applications due to their biocompatibility and physicochemical properties.

RESULTS

Table 2. Reduced viscosity value at different irradiation dose.

	Total absorbed Dose (kGy)						
	0	3	8	10	15	20	22
PVP Concentration (%)	Reduced viscosity(mL/g) per dose						
0.10	118.4 ± 0.04	53.1 ± 0.07	48.8 ± 0.04	40.86 ± 0.04	14.84 ± 0.02	35.45 ± 0.01	34.40 ± 0.05
0.175	121.1 ± 0.10	55.6 ± 0.10	59.0 ± 0.06	43.26 ± 0.07	20.73 ± 0.13	39.66 ± 0.04	35.86 ± 0.04
0.25	126.6 ± 0.07	58.53 ± 0.1	58.6 ± 0.05	47.34 ± 0.05	29.92 ± 0.05	41.61 ± 0.01	35.58 ± 0.07

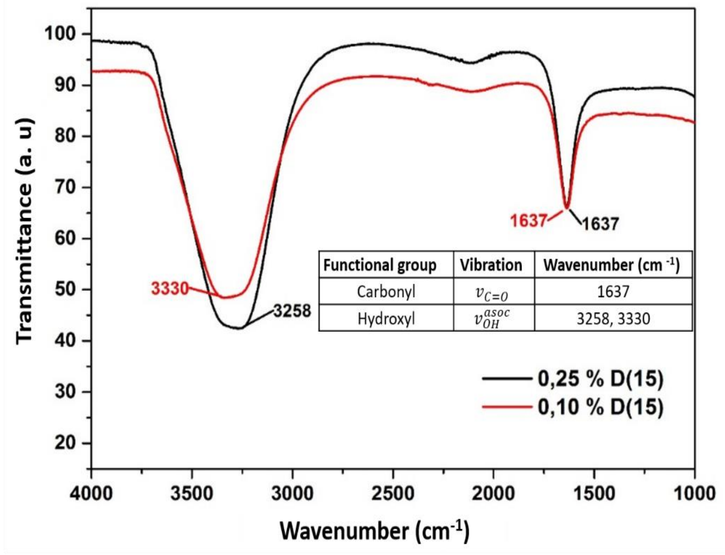

Fig. 2 PVP Concentration Influence on ATR spectra of PVP solutions at room temperature and 15 kGy.

Fig. 5 Influence of nanogel concentration on cell viability: a) 0.175%PVP at 15kGy

Table 3. Value of the Rh and Mw in PVP solutions at 15 kGy.

PVP Concentration (%)	Rh (nm)	Mw(Da)
0.10	18.49	(3.48 ± 0.01)E+06
0.25	19.44	(4.32 ± 0.01)E+06

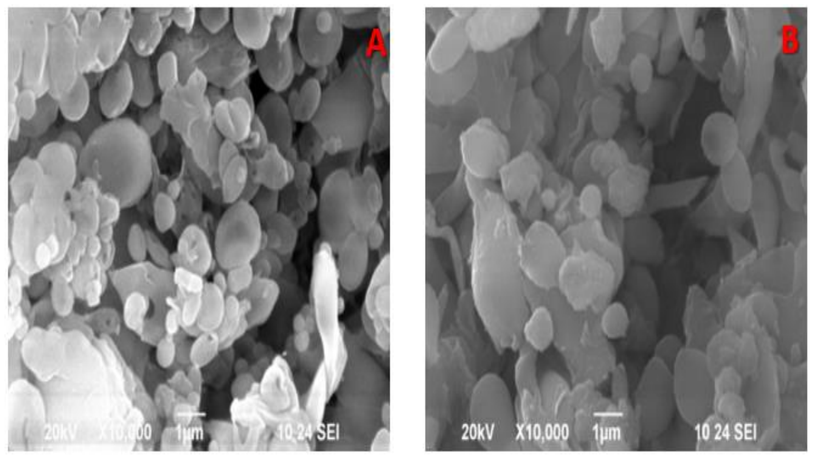

Fig. 3 SEM Image of PVP nanogels: A) 0.1 % concentration and B) 0.25 % concentration at dose of 15 kGy.

Fig.4 TEM image of nanogel (0.1 % PVP at 15 kGy) inside the human monocyte. The red arrow indicates nanogel in endosome.

REFERENCES

[1] Ulanski, P. Y., and Rosiak, J. M. 2004. "Polymeric Nano/Microgels." *Encyclopedia of Nanoscience and Nanotechnology*.
[2] Labhasetwar, V., and Leslie-Pelecky, D. L. 2007. "Biomedical Applications of Nanotechnology." *Nanogels: Chemistry to Drug Delivery*: 131-72
[3] Sultana, F., Md. Imran-Ul-Haque, M., Arafat, M., and Sharmin, S. 2013. "An Overview of Nanogel Drug Delivery System." *J App Pharm Sci* 3.
[4] Gogotsi, Y. 2006. *Nanomaterials Handbook.* New York, United Stated of America: CRC Press Taylor & Francis Group.
[5] Mozafari, M.R. 2007. *Nanomaterials and Nanosystems for Biomedical Applications.* AA Dordrecht, The Netherlands: Springer.
[6] J.M. Rosiak, P. Ulanski, P. Kujawa, I. Janik, P. Stasica, S. Kadlubowski, M. Kozicki. 2005. «Radiation-induced Transformations of Polymers in Aqueous Solutions.» *Eurasian ChemTech* 7: 225-50.