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GAMMA RADIATION USE FOR HYDROGELS OF POLY(N-VINYL 2-PYRROLIDONE) CONTAINING NANOCLAY LAPONITE

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ABSTRACT

Hydrogels are polymers that have a good biocompatibility with soft tissue. This polymer has properties to absorb water, because their crosslinked chains are hydrophilic. These materials have been used as wound dressing due to the capacity of swelling in the presence of water. The aim of the present study is to prepare a wound dressing with poly (N-vinyl 2 pyrrolidone) (PVP), poly (ethylene glycol), Agar and Laponite RD using gamma irradiation to crosslink the polymer and sterilization. The influence of irradiation process dose and laponite concentration (1 and 2%) were investigated according to the methodology of gel fraction and maximum swelling determination.

1. INTRODUCTION

Hydrogels are polymers with high molecular mass, due to three-dimensional networks of polymeric chains. Several methods are available to hydrogel synthesis including the process by gamma-irradiation in aqueous solution. This irradiation process allows one-step synthesis and sterilization of the hydrogel. [1-2]

Polymer in aqueous solution submitted to gamma-irradiation suffers radiolysis. As a result, short-lived reactive species are formed, as OH radicals, H-atoms and hydrated electrons (Equation 1). Hydrogen atoms and hydroxyls can extract hydrogen atoms of macromolecules, generating polymeric free radicals [3].

$$H_2O^{\text{ionizing radiationd}} = OH;\ H;\ {}^{\bullet}e^{-}aq \qquad (1)$$

Usually the polymers to obtain hydrogel are hydrophilic polymers. Hydrogels of natural and/or synthetic polymers are potential products to be used as wound healing dressing [4].

Poly (N-vinyl-2-pyrrolidone) (PVP) is a hydrophilic polymer and show an excellent biocompatibility. This polymer was widely used to obtain wound dressing in drug delivery systems. The addition of poly (ethylene glycol) (PEG) to improve properties such as elasticity and barrier against bacteria, usually is a biocompatible other than an hydro-soluble polymer. PEG is commonly used to increase the aqueous solubility of drugs [5-8].

The application of nanoparticles in materials, greatly increase their properties due to its large contact area. Small amounts of nanoparticles allows gains of properties in low concentrations. Laponite (LP), a synthetic nano-clay often used in personal care and pharmaceutical has chemical formula: $Na^{+}_{0.7}[(Si_8Mg_{5.5}Li_{0.3})O_{20}(OH)_4]^{-0.7}$, and its morphology has octahedral magnesium oxide lamella between two parallel tetrahedral silica lamella. This clay has a disk shaped form at about 1 nm of thickness and 25 nm of diameter [9-10].

2. MATERIALS AND METHODS

These present hydrogels were processed by gamma irradiation, and characterized by maximum swelling, determination of fraction gel for 3 weeks and 6 hours in soxhlet.

2.1. Materials

Poly (N-vinyl-2-pyrrolidone) (PVP) provided by Êxodo Científica, poly (ethylene glycol) provided by BRENNT AG, Agar provided by OXOID and Laponite RD Clay provided by BYK Aditives & Instruments.

2.2 Methods

2.2.1 Hydrogel Synthesis

PVP was diluted in water for 24 hours until complete solubilization. Laponite RD was solubilized in water under agitation, for 3,5 hours before to be added in the PVP solution. Agar and PEG were added. The final solution was heated at 80°C for five minutes using a hot plate with magnetic stirrer. 10 mL of solution were deposited in thermoformed molds of polyethylene terephthalate (PET) and irradiated at 25 kGy.

2.2.2 Gel Fraction

The gel fraction is the insoluble fraction of the polymer cross-linked, while the ol-fraction is related to the soluble fraction after extraction operation. There are two methods to determinate the gel fraction of the hydrogel, one uses a soxhlet extraction method consisting in 6 hours extraction at 100 °C and another with submersion into water for 3 weeks. In the both methods, the samples were removed and dryed in stove at 50°C for 12 hours and their weight measured. The fraction gel was calculed following equation 2:

$$\text{Fraction gel } \% = [Wf \,/\, Wi] \times 100 \quad . \tag{2}$$

W (i) is a weight before extraction
W (f) is a weight after extraction

2.2.3. Maximum swelling

The maximum swelling was determined by submersion of the hydrogel after syntheses, into water for 48 hours. The swelling is measured after each period of one hour up to 10 hours and one final measurement is taken after 48 hours. To calculate the maximum swelling was used the following equation 3:

$$\text{Maximum swelling \%} = [W(g-s)/W(s)] \times 100 \quad . \qquad (3)$$

3. RESULTS AND DISCUSSION

The sample of hydrogel with laponite exhibit a good transparency. Figure 1 shows the results of gel fraction obtained. It was observed similar results in the comparison of both methods. The variation of the results are not significant.

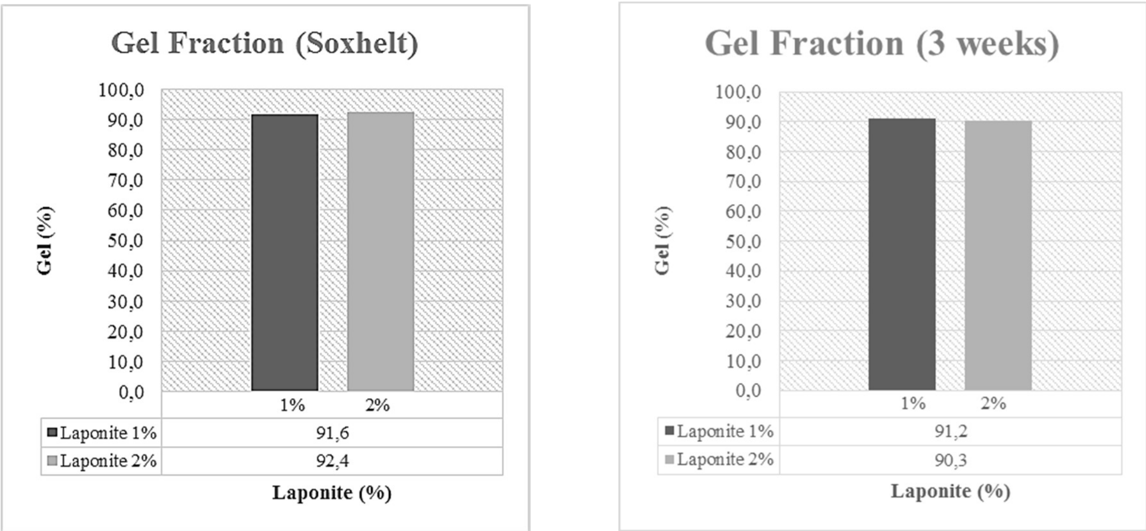

Figure 1: Graphic of Gel Fraction by soxhelt (6 hours) method and 3 weeks method.

In swelling test the samples exhibit similar maximum swelling, considerably lower than that sample without laponite.

Table 1: Maximum Swelling.

Laponite (%)	1%	2%	0%
Swelling (%)	25,7	25,4	16,5
Time (h)	48 hours		

The swelling between the LP 2% 0-24 hours shows a different rate. In the early periods of time the hydrogel with a 2 % of laponite presents a sligly lower swelling rate than the hydrogel with 1 % of laponite. Figure 2 shows the results of swelling obtained.

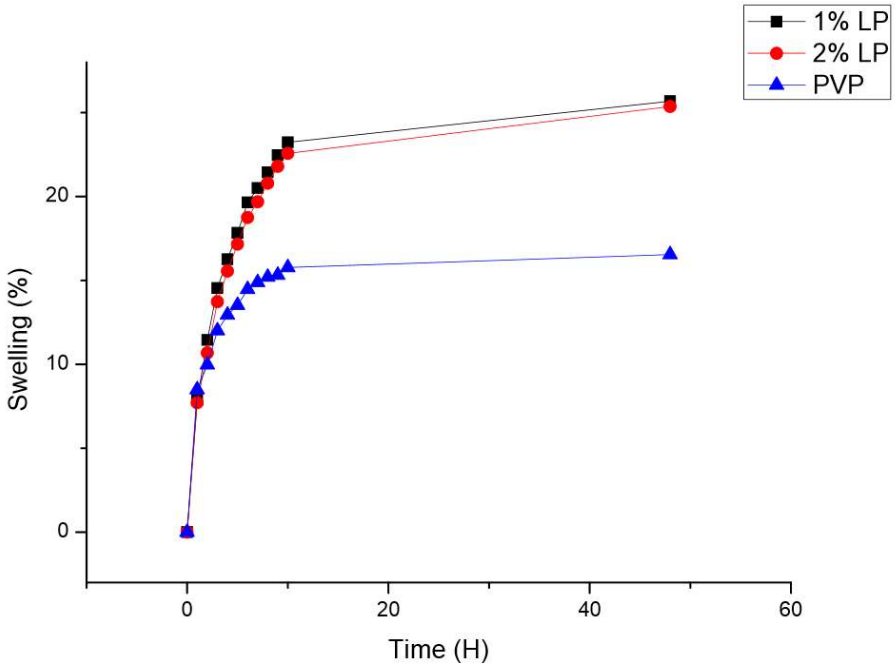

Figure 2: Graphic of swelling.

4. CONCLUSIONS

The gel fraction of hydrogel/LP with 1% and 2% of LP are similar and no significant difference was observed between them. The swelling capacity of hydrogels with laponite were higher than that hydrogel without laponite.

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