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BIODEGRADABILITY AND ECOTOXICITY ASSESMENT OF POLYMERIC BASED HYDROGELS

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Introduction: In our current situation, at a global level, the agricultural sector faces great problems such as continuous drought conditions or water scarcity, which increase the degenerative processes of the soil and seriously affects the quality of crops. Hydrogels, known as water holding reservoirs that can store a large amount of water and release it under controlled constant flow are highly studied by reserchers as a solution for these major problems. Biodegradability represents one of the most important requirements for these polymers that can be applied in agriculture and could represent a sustainable mechanism. Another requirement imposed on hydrogels refers to their lack of ecotoxicity, so that after the biodegradation process, no harmful compounds should be released into the environment.

Aims: The aim of this study was to test different formulations of hydrogels based on acrylic acid, carboxymethyl cellulose and sodium alginate regarding their biodegradability rate after 100 days in soil while assesing their ecotoxicity potential.

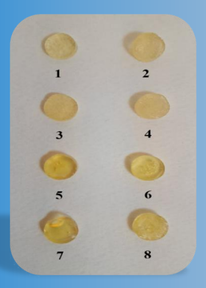
Tabel 1. The composition of hydrogel samples

Sample	Sodium alginate (g)	Carboxymethyl cellulose(g)	Acrilic acid (g)	$K_2S_2O_8$(g)
1	1.5	-	20	0.1
2	1.5	-	20	-
3	2.0	-	20	0.1
4	2.0	-	20	-
5	1.5	2	20	0.1
6	1.5	2	20	-
7	2.0	2	20	0.1
8	2.0	2	20	-

Materials and Methods: The hydrogels were obtained from National Institute for Laser, Plasma and Radiation Physics. The biodegradability was tested using the soil burial method adapted after the standard SR EN ISO 846 using 8 different hydrogel compositions and electron beam radiation. The ecotoxicity was assesed using the seed germination bioassay (Mileluț & Popa, 2020) on seeds of *Lactuca sativa* and *Raphanus sativus. D*ifferent concentrations of soil after biodegradation extract were obtained (0%, 25%, 50%, 75% and 100%) were applied and after incubation at 25°C for 72 hours in the dark, germinated seeds were counted (G) and root lenght (L) was measured. The germination index (Gi) of the samples was calculated according to the formula $Gi=G/G_0*L/L_0*100$, where G_o and L_o are respectively the germination percentage and root growth of the 100% dH2O control. The Global germination index (GI) was the Gi averages of the 50% and 75% dilution treatments. The GI has been proved to be a very sensitive index (Tiquia et al., 1996) indicating nonphytotoxicity of the soil when the values are higher than 80%.

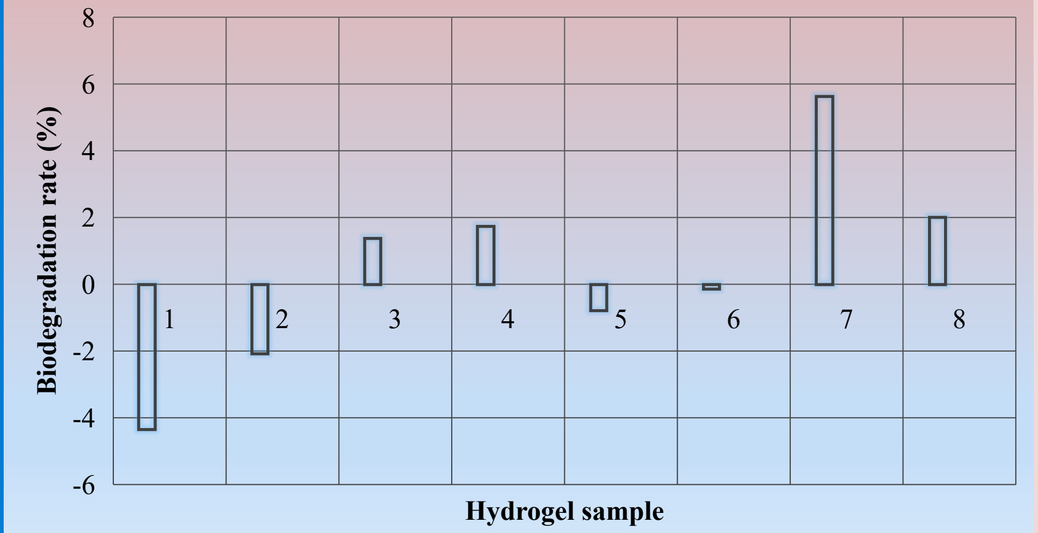
Results: The biodegradability testing showed a greater rate of biodegradability for the sample containing a higher amount of sodium alginate, carboxymethyl cellulose and $K_2S_2O_8$ (sample 7) with of 5% biodegradation of the polymeric material. The hydrogel containing the same composition excepting $K_2S_2O_8$ (sample 8) achieving a 2% biodegradability rate after 100 days in soil. Regarding the ecotoxicity of the polymers, the germination rate and rootlet length were close or higher for the tested samples, compared to control with few differences for the radish seeds. The global index of germination was close (Sample 1) or higher than 80%. The GI of the lettuce seeds proved to be low for all the samples tested, the range varying between 5-25%.

BIODEGRADABILITY TEST



Hydrogel samples

Biodegradation system



The hydrogels biodegradation rate after 100 days in soil

Conclusion: The results of the study showcased a promising process of biodegradation of the hydrogels for the materials containing a higher amount of sodium alginate and carboxymethyl cellulose after 100 days of biodegradation in soil.
The ecotoxicity assessment showed no significant phytotoxicity of the soil extract after 100 days of biodegradation for the radish seeds as opposed to the lettuce seeds that presented a greater rate of inhibition of the germination capacity and root growth, the Global Germination Index not exceeding over 25%.

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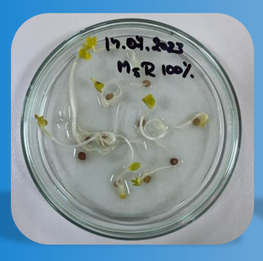
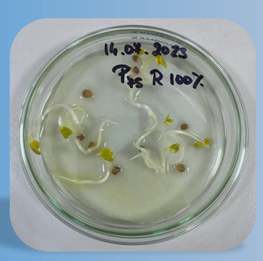
ECOTOXICITY TEST

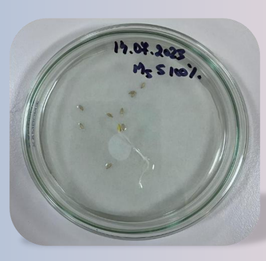
Radish (*Raphanus sativus*) seeds

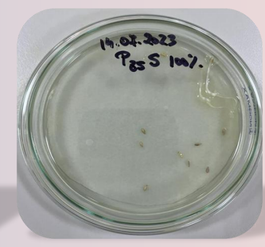
Lettuce (*Lactuca sativa*) seeds



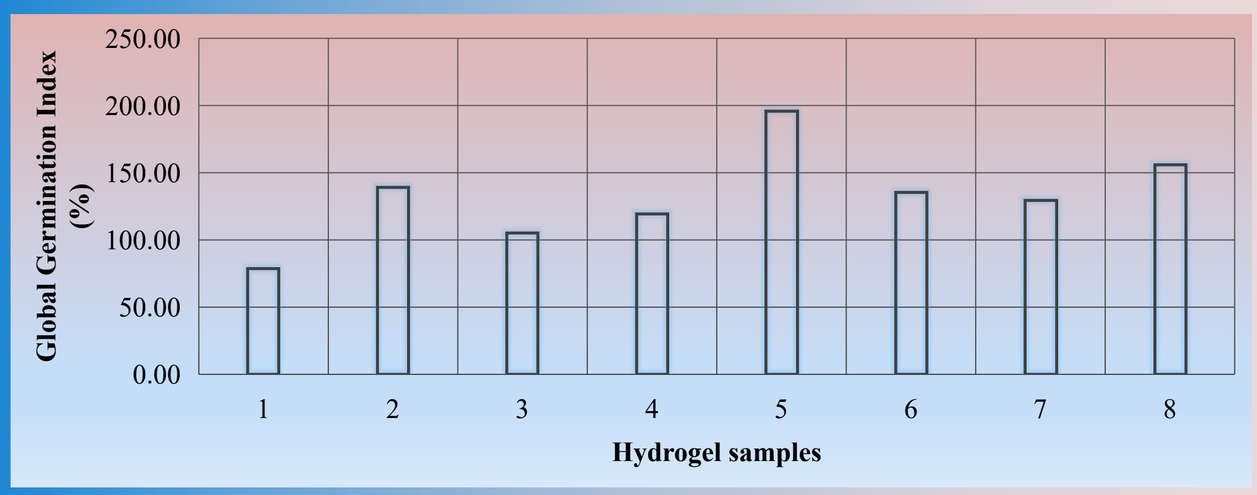


Radish seeds germination in 5 ml soil extract without hydrogel biodegradation (left) and after 100 days biodegradation (right)

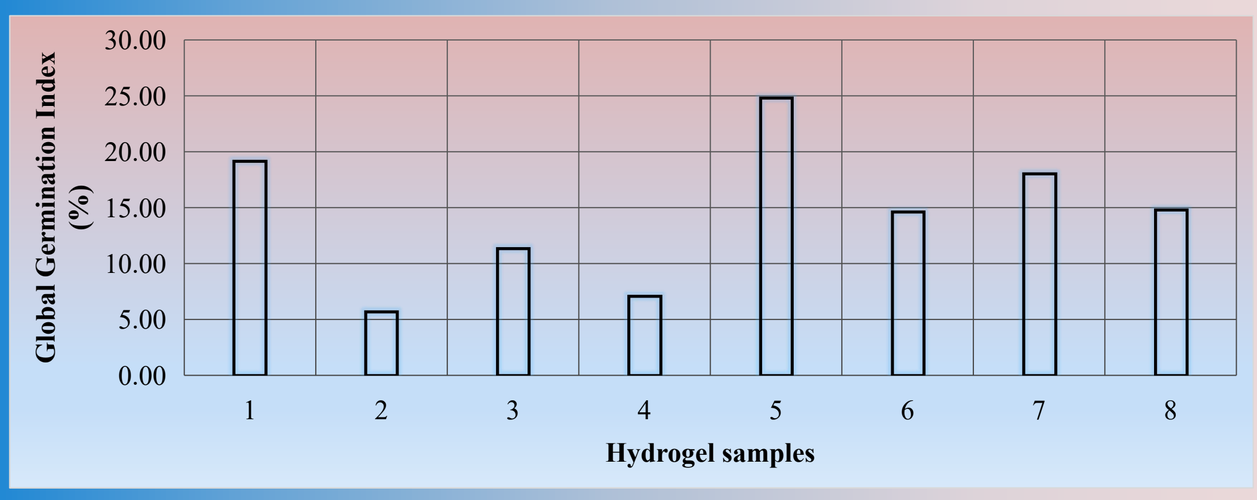




Lettuce seeds germination in 5 ml soil extract without hydrogel biodegradation (left) and after 100 days biodegradation (right)



The Global Germination Index (GI) of radish seeds



The Global Germination Index (GI) of lettuce seeds