DEVELOPMENT OF SEED COATING AGENT WITH ι-CARRAGEENAN HYDROGEL FOR SUSTAINABLE AGRICULTURE

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Feeding 9.6 Billion People…

- United Nations[1] estimated human population to reach **9.6 billion by the year 2050**
- World food production must increase even more to meet **food demand**
- **Pollution & environmental damage** caused by agriculture is currently a major concern
- Climate change – **drought** also becoming a threat for field crop cultivation
- **Sustainable agriculture** is essential to protect the environment while increasing food production
- **Natural hydrogels**[2,3] are key materials that can promote plant growth in critical conditions while keeping environmentally-safe

Fig. 1: Uncoated (left) and coated (right) wheat seeds with agar/ι-carrageenan hydrogel.

Project Aim

This project is based on the concept of applying hydrogel technology for agricultural/horticultural use.

The aim is to film coat seeds (**Fig. 1**) with environmentally friendly hydrogels (**Fig. 2**) made of natural polymers such as ι-carrageenan (**Fig. 3**) that are biodegradable and non-toxic.

Potential benefits include:

- Faster and higher seed germination rates (**Fig. 4**)
- Promote water and soil conservation
- Provide protection of seeds against pests
- Low material cost[4] and safe handling

Fig. 2: Dry hydrogel (left) swells up (right) by soaking up water.

Fig. 3: ι-Carrageenan (right) extracted from red seaweed (left).

Fig. 4: Grass growing better in the presence of ι-carrageenan hydrogel (right) but less in the pot without the hydrogel (left).

Preparation of Hydrogels and Analytical Tests

1. Hydrogels were formulated by blending natural polymers

- Agar/ι-carrageenan blend (**AC**) hydrogel

2. Hydrogels were characterised by swelling studies (Fig. 5) in:

- 0.1 M NaCl and $CaCl_2$ solutions
- pH 4, 7 and 10 buffer solutions
- The weights of dry and swollen gels were recorded in set time intervals for up to 168 hr

Fig. 5: Example of dry **AC** hydrogel (left) swelling after 24 hours in distilled water (right).

Swelling studies in Saline solutions

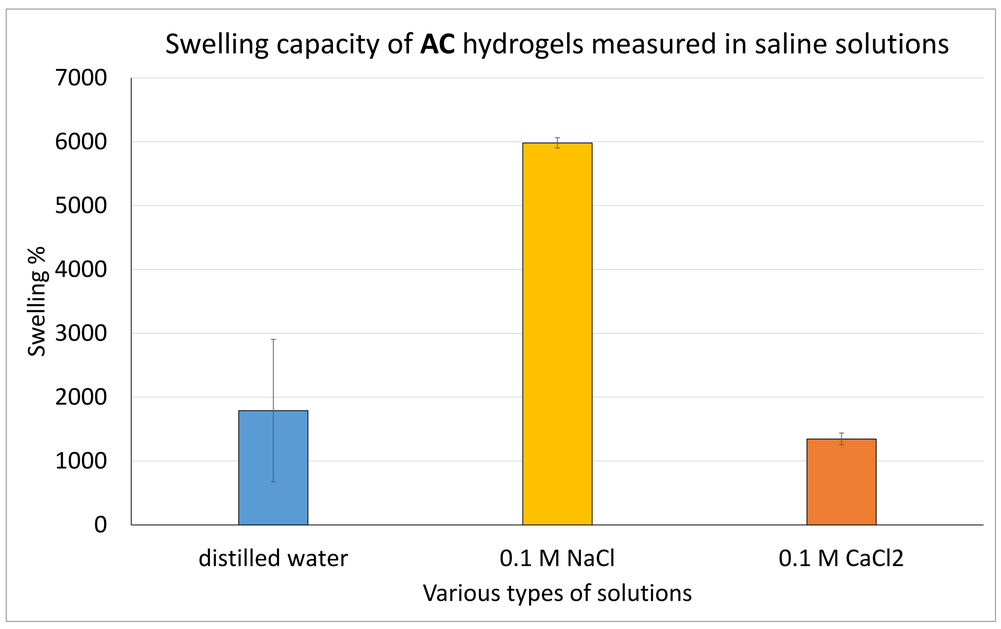

Fig. 6: The swelling % of agar/ι-carrageenan (**AC**) hydrogel in distilled water (blue bar), 0.1 M NaCl solution (yellow bar) and 0.1 M $CaCl_2$ solution (orange bar) measured at 22±2°C after 168 hrs.

From this study it was found that the natural agar/ι-carrageenan (**AC**) hydrogel under was more sensitive to $CaCl_2$ solution than NaCl solution. It was also noticed that in both saline solutions, the **AC** hydrogels showed higher resistance to disintegration compared to the hydrogels kept in distilled water shown by the large error bar (**Fig. 6**). In summary, the swelling % of the **AC** hydrogel and its life-span can change by the difference in the types of salt present in the water.

Swelling studies in pH buffer solutions

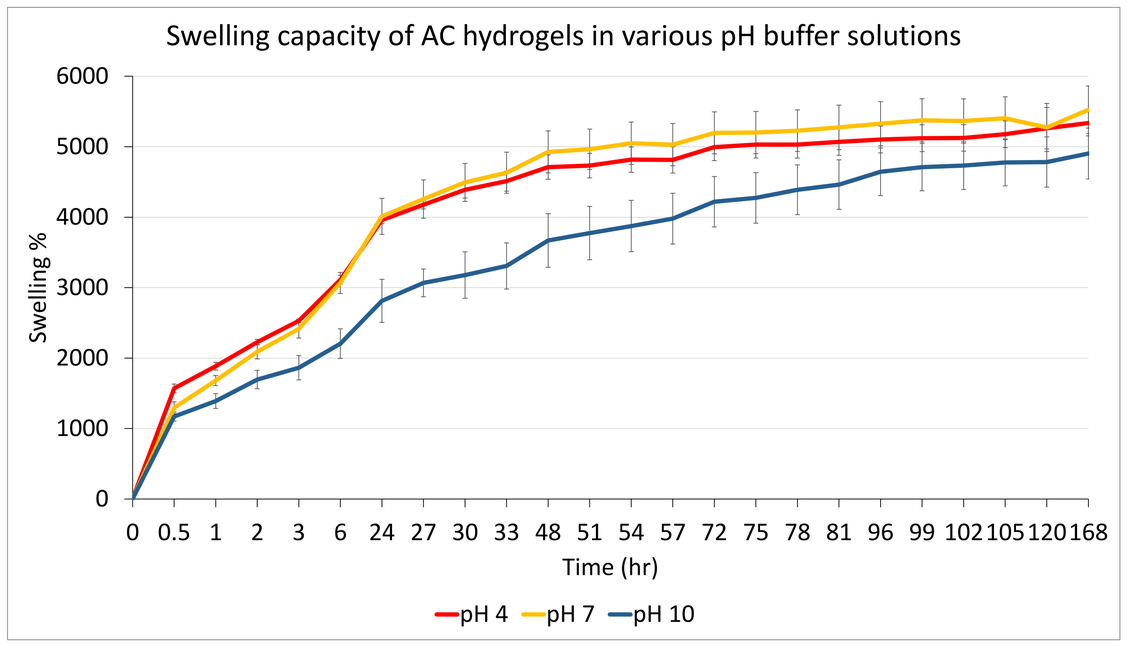

Fig. 7: The swelling % of agar/ι-carrageenan (**AC**) hydrogel in pH 4, 7 and 10 buffer solutions measured at 22±2°C for 168 hrs.

From this study it was found that the swelling capacity of natural agar/ι-carrageenan (**AC**) hydrogel under pH 4 and 7 were similar but tended to reduce in pH 10 buffer solution (**Fig. 7**). Particularly at times between 0.5 to 72 hrs seemed to swell less in pH 10 than the other two buffer solutions. The swelling % then gradually increased until it reached closer to those of the hydrogels in pH 4 and 7. The **AC** hydrogel swelling rate changed by the change in the pH of the solution.

Summary and Future Work

The novel agar/ι-carrageenan blended hydrogel coating showed some interesting swelling characteristics under different types of saline solutions and pH levels. The hydrogels acted as smart-gels[5,6] where it changes its swelling behaviour depending on the change in stimulation by the surrounding environment, typically ions, pH levels, or temperatures for example.

Applying the concept of smart-gels which acts as a controlled drug releasing device, incorporation of 'green pesticides' and or 'beneficial microbes' into the hydrogel is suggested for future work in this study, in order to provide protection of seeds and further growth promoting effect. The controlled release of these active ingredients can greatly promote sustainable pesticide or nutrient management which could contribute to the reduction of pollution into the environment without reducing crop yield.

The preliminary germination study gave an insight to the use of our novel natural hydrogel as seed coatings to speeding up germination for wheat seeds[7]. It is anticipated that this natural seed coating can be applied to different variety of seeds and contribute to future food sustainability.

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