

DEVELOPMENT OF SMART SEED DELIVERY SYSTEMS USING NATURAL HYDROGELS



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Introduction

This project is based on the concept of applying hydrogel technology for agricultural/horticultural use. The aim is to film coat seeds with natural hydrogels to enhance their survival rate in dry soils as well as achieving higher and faster germination rates.

Hydrogels are hydrophilic polymers forming semi-solid materials that can retain large amount of water into their network¹. Some can soak up to as much as 500 times their weight in water, yet, they can also release it when they are exposed to a hot dry environment. This unique property of hydrogels have been applied in the agricultural and horticultural sectors in recent years². In the past mainly synthetic hydrogels such as polyacrylamides have been used. However they are now becoming a threat as their degradation products are toxic to the environment³.

This project aims to coat seeds with environmentally friendly hydrogels, made of natural polymers that are biodegradable and non-toxic. Potential benefits include fast and higher seed germination rates, protection against pests, reduced soil contamination, water conservation, safe handling and low material cost.

**The materials used in the preparation of hydrogels cannot be disclosed as an Innovation Disclosure Form (IDF) has been signed by AIT. Initial studies have provided very promising

Project aims

1. Formulation of biodegradable, non-toxic hydrogel seed coating system
2. Characterisation of hydrogels
3. Application of hydrogel in film coating process (Figure 1)
4. Incorporation of green pesticides/ nutrients
5. Field test with film coated seeds

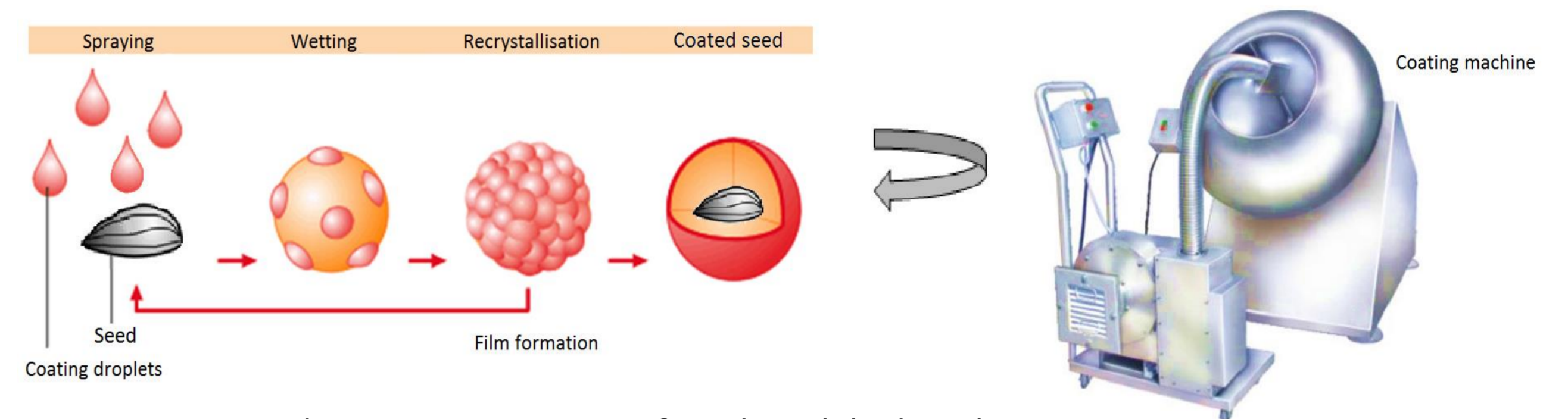


Figure 1. Proposed pan coating process of seeds with hydrogel.

Methodology

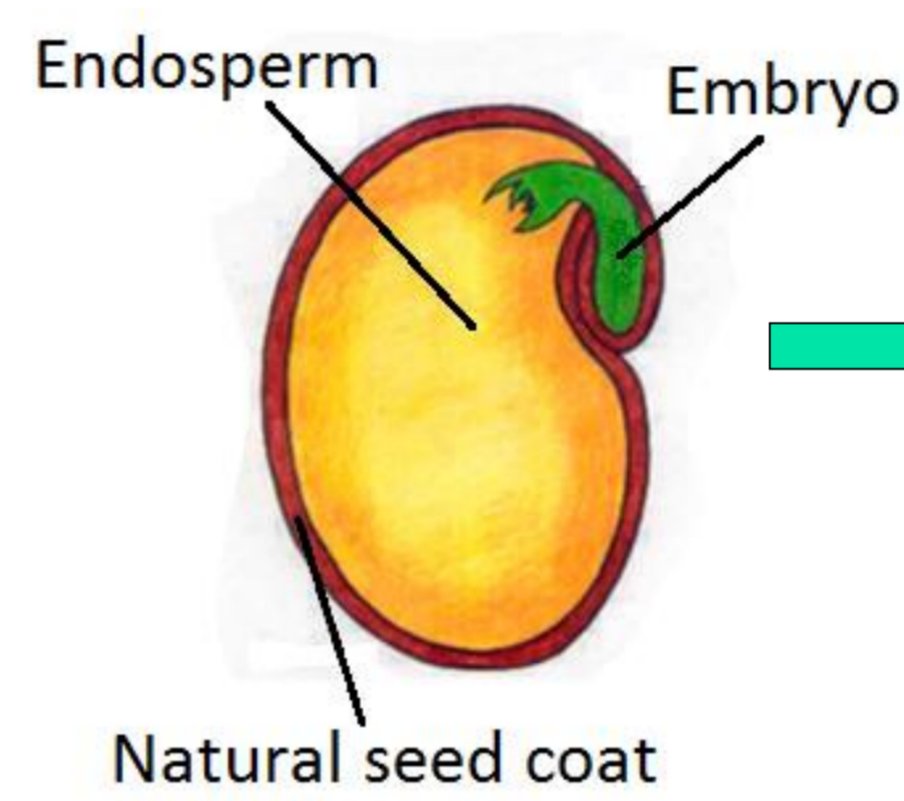
Development and application of hydrogel coating

- Hydrogel blending technique: Four types of hydrogels**, A, B, C and D were formulated by adding natural polymer s to the base material.
- Coating seeds with hydrogel using tablet coating machine (Figure 1)
- Examination of germination rate of coated and uncoated seeds (Figure 2)

Analytical tests

- Swelling / De-swelling studies (Figure 3)
- Rheometry for mechanical strength studies (Figure 4)
- Chemical identification using Fourier Transform Infrared spectroscopy (FTIR)
- Coating thickness measured with Scanning Electron Microscope (SEM)
- Thermal analysis using Differential scanning calorimetry (DSC)

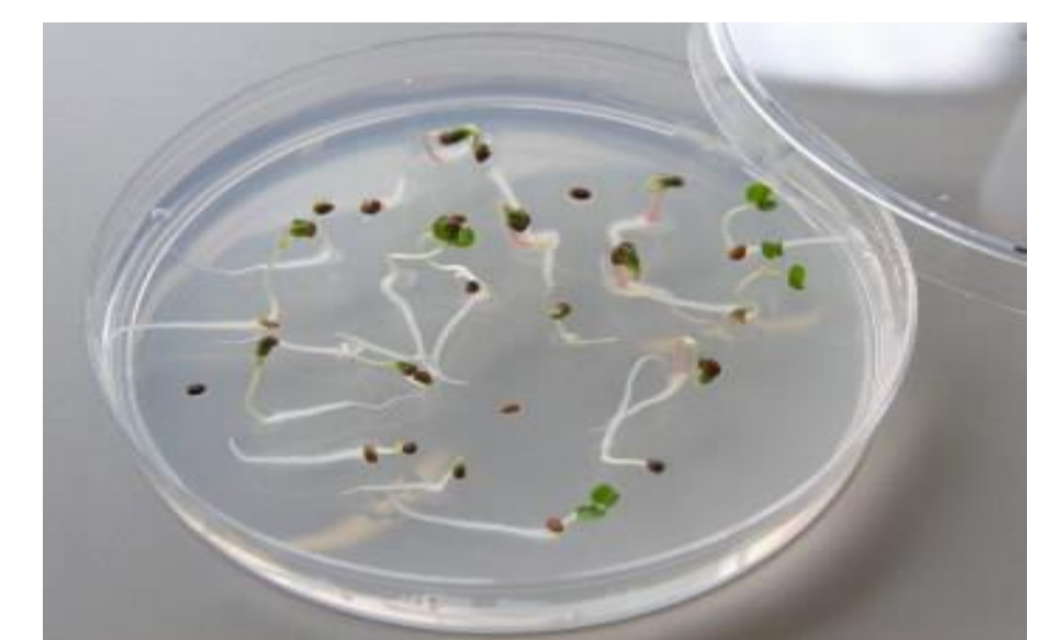
General seed structure



Germination requirements

- Moisture
- Temperature
- Oxygen

Germination occurring in hydrogel



Natural seed coat

Figure 2. Seeds capable of germinating in hydrogel and its potential use as a carrier of seed protectants and nutrients.

Swelling studies

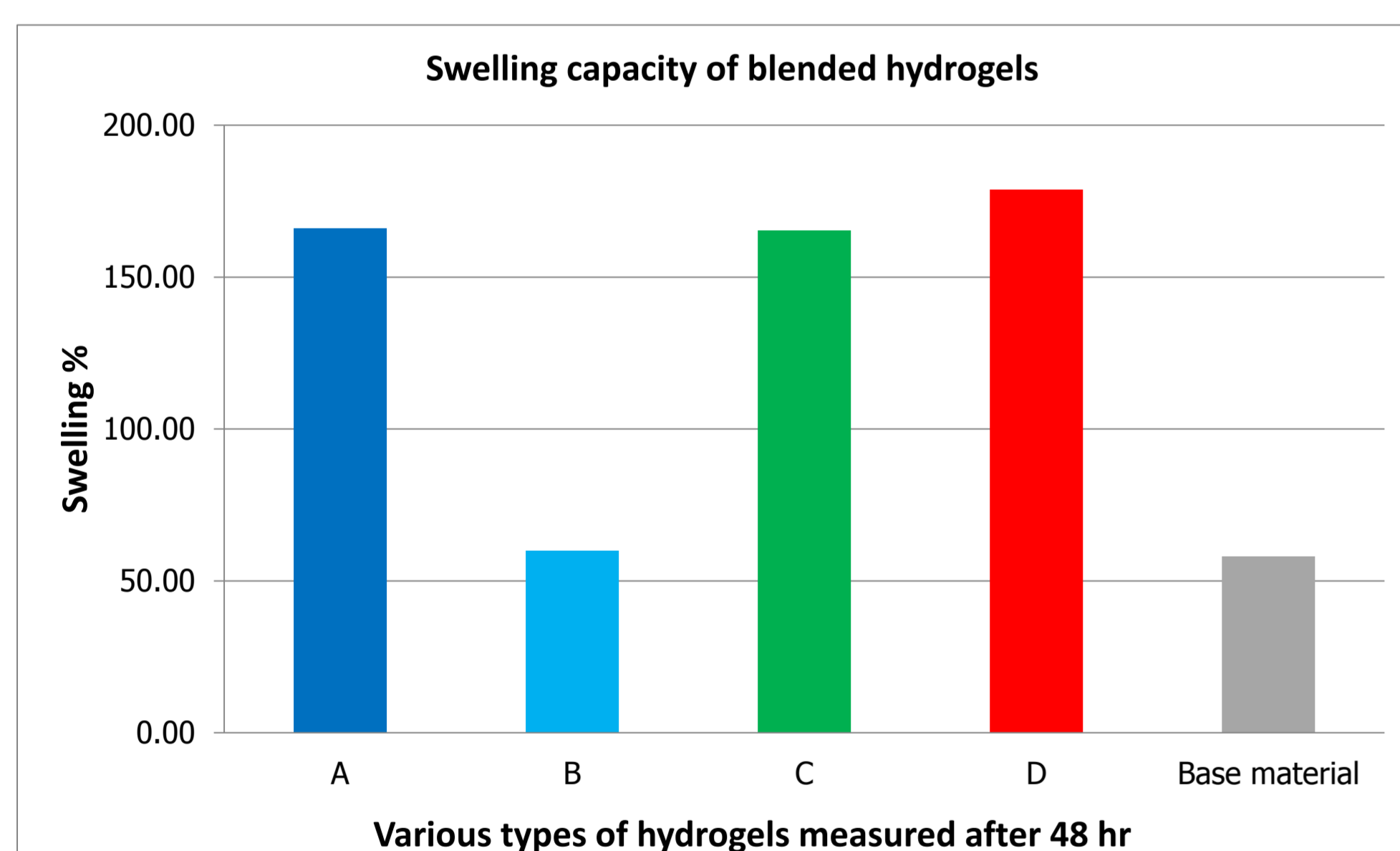


Figure 3. Swelling rate of blended hydrogels soaked in distilled water for 48 hours.

Figure 3 shows the difference in water absorption capacity of each gels measured at $22 \pm 1^\circ\text{C}$ after 48 hours. The highest water absorption was observed for batch D.

Mechanical strength

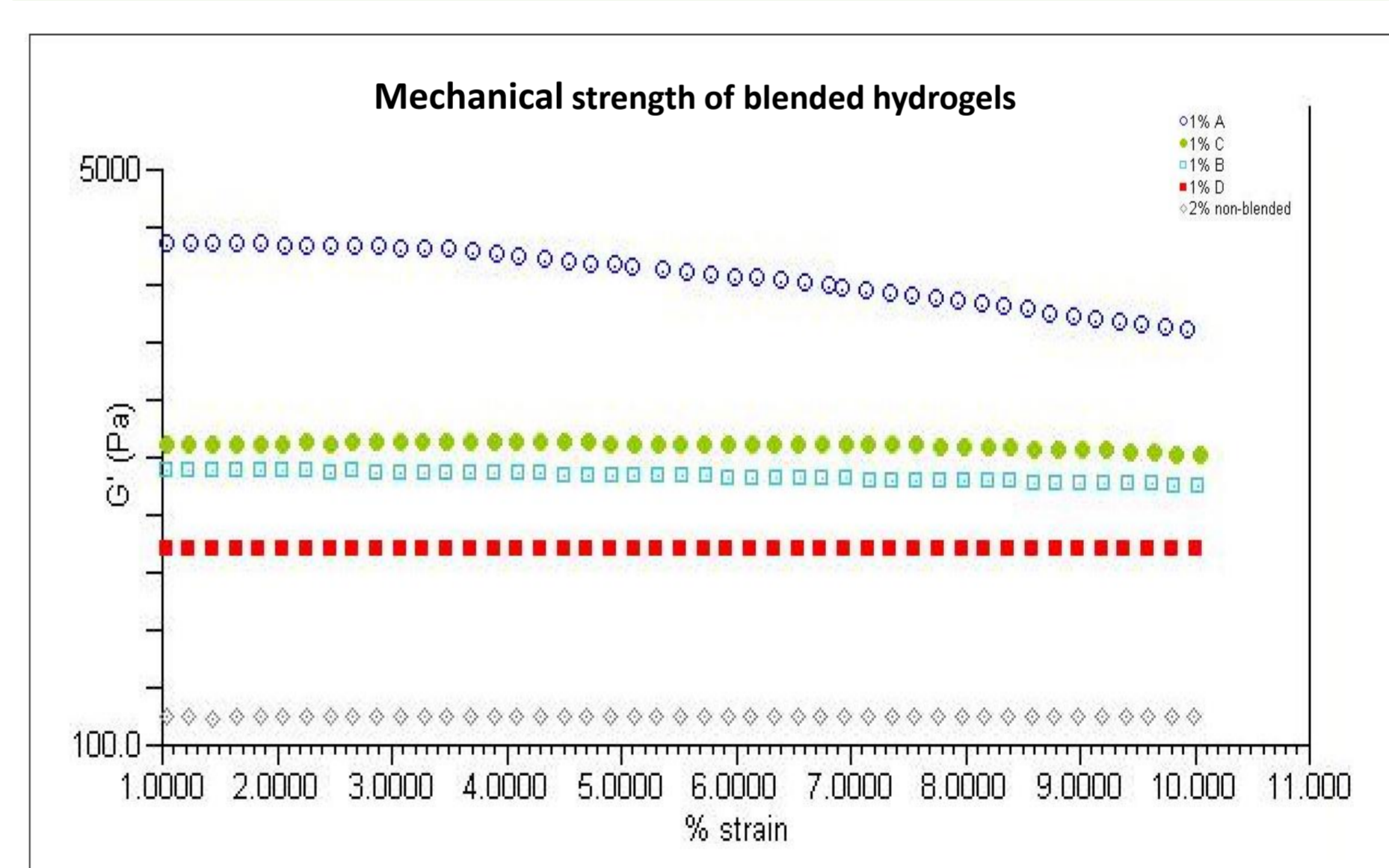


Figure 4. The mechanical strengths of blended hydrogels each containing 1% (w/v) of additives; A, B, C, and D with 1% of the base material. The non-blended hydrogel consist of 2% base material.

An oscillatory strain sweep was carried out at a frequency of 1 Hz. The hydrogel with the highest mechanical strength was observed for batch A, giving the highest G' value shown in Figure 4.

Future work

Initial studies using the base material had promising effect on speeding up the germination rate of seeds. The blending of several types of natural polymer improved the water imbibing capacity (Figure 3) and the mechanical strength (Figure 4) of the base material. Further studies will be conducted in order to establish the coating system, coating process, and incorporation of 'green pesticides' and nutrition to provide seed protection applying the concept of smart-gels (also known as intelligent gels) which acts as a drug release controlling device⁴.

References:

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3. MasterGardener. (Autumn 2007) *Miracle, myth...or marketing: Super-absorbent water crystals*. [Online]. Available at: http://www.puyallup.wsu.edu/~linda%20chalker-scott/horticultural%20myths_files/Myths/magazine%20pdfs/MythsHydrogels.pdf [Accessed 31st January 2013].
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Applications

Once faster and healthier germination rates of seeds have been achieved using these environmentally friendly hydrogels we aim its applicability to developed to the following areas:

- Increasing food sustainability
- Drought prevention
- Water conservation
- Soil conservation
- Reduced toxic material exposure to humans and animals