Alinteri J. of Agr. Sci. (2021) 36(1): 753-756
e-ISSN: 2587-2249
info@alinteridergisi.com

http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/
DOI:10.47059/alinteri/V36I1/AJAS21105

RESEARCH ARTICLE

Eco-friendly Biodegradable Super Absorbent Polymers (SAPs); An Effective Water Retainer and Agrofertilizer

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ARTICLE INFO

Article History:
Received: 18.04.2021
Accepted: 18.05.2021
Available Online: 28.06.2021

Keywords:
Carrot Peel
Potato Peel
Fertilizer
Pollution Controller

ABSTRACT

A polymer is a material which consists of very large molecules, or macromolecules, composed of many repeating subunits. They are classified as synthetic and natural polymers both play essential roles in everyday life due to their broad spectrum of properties. The foremost important class of polymers is superabsorbent polymer (SAP) materials. They are hydrophilic networks which absorb and retain large amounts of water. SAPs are originally divided into two main classes. They are Synthetic (Petrochemical based) and Natural (e.g.; Polysaccharide and Polypeptide based). Most of the present superabsorbent polymers are frequently produced from acrylic acid and acrylamide solution or inverse-suspension polymerization techniques. These are not biodegradable and are harmful to the environment that causes pollution. So, we sought to make biodegradable SAP that can act as a fertilizer to improve the soil quality and water conservation in agricultural land.

Please cite this paper as follows:

Dr. Sudhakar, K., Amalraj, L., Tejaswini, V.L., Sree, N.M., Harshitha, P.D. and Julie, M.R. (2021). Eco-friendly biodegradable Super Absorbent Polymers (SAPs); An Effective Water Retainer and Agrofertilizer. *Alinteri Journal of Agriculture Sciences, 36*(1): 753-756. doi: 10.47059/alinteri/V36I1/AJAS21105

Introduction

Biopolymers are natural biodegradable polymers that possess various properties [1] and applications. Polysaccharides like starch, cellulose and proteins are the great samples of natural polymers and main renewable sources of biopolymers. Superabsorbent polymers (also called as slush powder) are the special type among all polymers which absorb and retain an outsized quantity of a liquid relative to its own mass.[2-3] To avoid dissolution they contains a network of polymer chains which are cross linked.

Along the polymer chains there are ionic functional groups to encourage diffusion of water within the network. Hydrogels are defined as polymeric materials which exhibit the power of swelling in water and retaining a big fraction of water within their structure, without dissolving in water. Special hydrogels as superabsorbent materials are widely employed in hygienic uses particularly disposable diapers and sanitary napkins.[4] In recent years, bio-waste, especially agricultural by-products like starch, soya protein has been considered for the preparation of SAP. These bio-wastes are non-toxic, renewable, biocompatible, and biodegradable. As carrot peels and potato peels also are considered as agricultural by-products we made SAP using them. The proposal of this scheme not only improves the use of biological waste, but also reduces the

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production cost of SAP. Our objective is to synthesis "Biodegradable SAP using Potato and Carrot peels".

Potato Peel as Sap

They're completely chemical-free that increases soil fertility. The potato peel mixture is definitely available in any season. the world production of potato peels is estimated to be 70–140 thousand tons/year. The produced peels could be used for a variety of purposes, including production of biogases, feedstock, and fertilizers. So, we will also make use of it to supply SAP in large quantities. it's the ability to extend crop yields. The potato SAP act nearly as good "GELLING AGENT" that posses the power to soak up great quantity of water.

We used potato peel because it contains good amount of pectin. Pectin is a polysaccharide consisting of galacturonic acid (GalA) that's found within the cell membrane of plant. The skin of the potato possesses phytochemicals that acts as a strong antioxidant and nutrient donor. Potato peels play a role of fertilizer which promotes the plant growth. Potato features a unique capacity of adsorbing dirt and it also can adsorb "HEAVY METALS". Adsorption of Heavy Metals onto raw potato peel (RPP) and Brunt potato peel (BPP) acts as adsorbents (RPP and BPP) proved to adsorb Heavy Metals like Cd(II), Co(II), Cu(II), Fe(II), La(III), Ni(II), and Pb(II) from aqueous solutions. As this potato skin adsorbs heavy metals we will protect the soil from pollution. [5-7]

Carrot Peel as Sap

The carrot peel contains nutrition like vitamin A, beta carotene which is vital to health. They contain anti-oxdiants, lutin and zeaxanthin which prevent age related macular degeneration, a kind of vision loss. Carrot is rich in many nutritional components, like polysaccharide, ß-carotene and vitamin C.[8] The peel from carrots will rot down into compost very quickly. Dietary fiber, especially pectin, is one the foremost abundant components in carrot peels.

Carrot is rich in many nutritional components, like polysaccharide ß-carotene and vitamin C. Carrot peels are rich in polysaccharides like pectin. Carrot peels can simply be buried and became compost. This process involves good microorganisms in the soil breaking down the organic matter because the microbes break down the carrot peels, it leaches the potassium into the soil which can then be absorbed by the plant. When added to the soil, it can provide vitamin A and C to the plants. The peel from carrots will rot down into compost very quickly

Materials Required

The reagents used here to prepare SAP are Carrot peels, Potato peels, dried coconut and rice water.

Preparation of SAP

Take out carrot peels from carrot. Pour rice water in carrot peels bowl. Boil the carrot peels in rice water. Keep that mixture undisturbed for one hour. Now take a cotton cloth and remove the excess water from the carrot peels. Take a dried coconut and slice it into pieces. Cut the carrot peels into fine pieces and add sliced coconut. Now dry them under the sunlight. Take out potato peels from potato and dry them under sunlight. Make sure that they dry properly under sunlight. Now take those dried peels. Cook them for 15-20 minutes. Take sliced coconut and make coconut powder. Add coconut powder to dried peels and mix them thoroughly. Our biodegradable SAP is prepared.

Results and Discussion

The super absorbent polymers have been prepared in simpler manner as shown in figure 3.1 and 3.2 at day 1 and day 20 respectively. SAP containing carrot and potato peel tested for water retention ability. The result indicates that the SAP holds high water absorbing ability.

Figure 3.1. SAP at DAY 1

Figure 3.2. SAP at DAY 20

Water Absobing Ability

We observed that the *"Carrot peel mixture"* absorbed the most amount of water yielding a result of 76.1%

compared to Acrylic SAP which yields 74.7%.The carrot peel powder absorbed 64% of water and the orange peel solution absorbing only 53%.

The SAP samples are immersed in 100ml of distilled water. Then the slurry was filtered through a course glass filter for 10 minutes. The amount of water retained can be calculated through this formula,

Water Retention = $(G_S - G_i) / G_i$, Where, G_S is the weight of the water absorbed SAP and G_i is the initial weight of SAP sample.

In flower pots commercial top soil is mixed with 1kg soil. The super absorbent polymer is present in one flower pot. The SAP itself acts as fertilizer so we do not need to add any other fertilizer to get enough nutrients. About 4grams of SAP was mixed with the soil. After planting, the plants in the pot were measured from the soil level to top leaf after 5, 15, 20 days. The measurements were taken when appreciable difference was observed in the plants. The heights of the plants in the pots[9] were averaged and the values are presented in the following table 3.1 and figures 3.3 to 3.6.

Table 3.1. Plant watering schedule

Number of days after planting	Amount of water per day(ml)
0	200
5	100
10	50
15	0
20	0

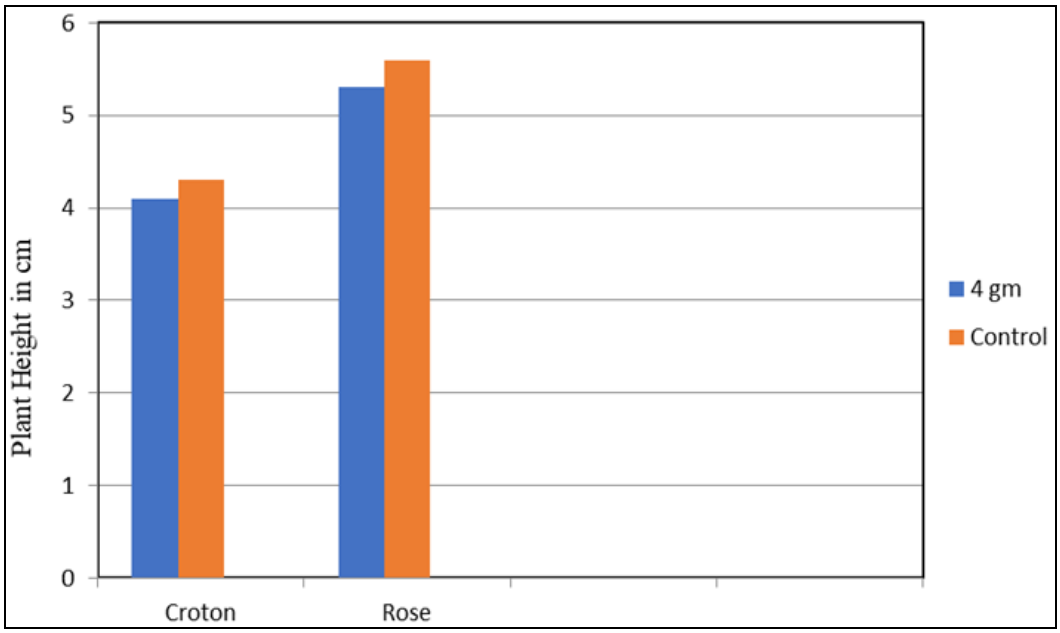

Figure 3.3. Growth comparison for plants in SAP amended soils at day-5

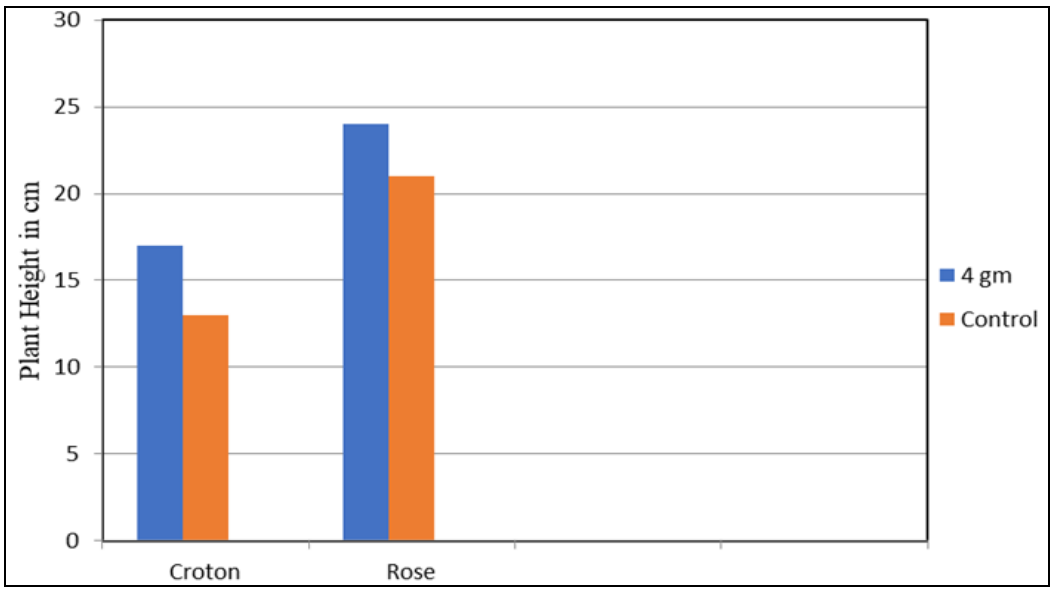

Figure 3.4. Growth comparison for plants in SAP amended soils at day-20

Figure 3.5. Croton and Rose plants at day 20 (without SAP).

Figure 3.6. Croton and Rose plants at day 20 (with SAP)

Figure 3.3 and 3.4 shows the growth comparision of plants when the SAP is mixed. Overall in the study period, the plants showed an upraising growth for all planting conditions. The SAP mixed plants have grown faster than without the SAP mixed plants. The SAP mixed plants have shown healthier growth and weight than the other plants. Table 3.2 shows the detailed comparision of our SAP's with Kiara and general SAP and confirms that the above prepared SAP is a very good fertilizer and water absorber.

Table 3.2: Comparison of SAP's

OUR SAP	KIARA'S SAP	GENERAL SAP's
✓Our SAP contains organic vegetable peels where each and every peel acts as a fertilizer. ✓Peel can remove harmful residue of pesticides, potato peels can act as heavy metal adsorber. ✓Our SAP is inexpensive and can be made at any conditions.	✓Kiara made SAP with orange and avocado peels, this SAP works only as water absorbent. ✓Generally, avocado is a seasonal fruit so it is difficult to make SAP when it is not available.	✓Reduction of stiffness / mechanical property when water is absorbed. ✓Its absorbing capability reduces if the water contains salts or any type of electrolytes.

Conclusion

The SAP which we made is biodegradable and does not cause any harm to the environment. Our synthesized SAP stores large amount of water compared to the other SAPs available in the market. The SAP can act as a natural fertilizer since we made the SAP using vegetable waste. The SAP not only nourishes the plant with water but also nourishes the plant with essential nutrients that helps in pant growth. SAP helps in maintaining Ph neutrality after swelling in water. The presence of Potassium, Phosphorus and starch present in rice water gives these minerals to the SAP. The "CARROT PEEL MIXTURE" not only posses water absorbing ability on the same level of the most famous commercially better water absorbing and retaining abilities. Potato is used as simple and renewable absorbents for water purification. So, the SAP which we made is completely biodegradable and it causes no harm to the environment instead it can be used as fertilizer and pollution controller.

The synthesised SAP can be mixed with SEED Ball. So, the seed germinates at faster rate by absorbing water. It can be applied to agro based industries, agro-farming and agriculture, nutrients and fertilizer. Due to super high water absorption and water retention capacity, SAPs can be applied to effectively ameliorate utilization of water in agriculture such as retaining moisture in the soil.

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