

Biodegradable Guar Gum based hydrogel

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Abstract : Biodegradable hydrogel made from Guar gum (GG) and polyacrylamide (PAA), using potassium permanganate as a cross-linker that provides Mn ions for chelating. Guar gum, polyacrylamide and potassium permanganate (GGPAAK_m) based hydrogel is a biodegradable hydrogel which is synthesized to use in the field of agriculture in dry places. Superabsorbent hydrogel absorbs water more than 200 times than its weight. The characterization of the prepared hydrogels (GGPAAK_m) is done by Fourier-transform infrared spectroscopy (FTIR), Scanning electron microscopy (SEM), TGA (Thermal-Gravimetric Analysis) and swelling in the distilled water.

(Keywords : Guar gum, Polyacrylamide, Superabsorbent and TGA)

Introduction

Water, nutrients and biodegradable materials which do not create any type of pollutant accumulated in the soil are needed for good yield of agricultural crops. So, a material which was synthesized, that act as water and nutrient reservoir, as well as biodegradable in nature. Guar Gum was selected for this purpose and synthesized guar gum based hydrogel acts as superabsorbent hydrogel. In this research, guar gum, polyacrylamide and potassium permanganate has been used to synthesize superabsorbent hydrogel (GGPAAK_m). GGPAAK_m (S-3) are considered as a water reservoir due to its outstanding ability to absorb water more than 200 times than its weight in its three dimensional network because it has functional group (O-H, N-H and C=O) which involved in water absorption¹⁻⁴. Super absorbent hydrogels are also

known as biodegradable hydrogel because it has been synthesized from biodegradable guar gum and polyacrylamide. GGPAAK_m can be used to plough agricultural land in desert area because it releases absorbed water and nutrient in the soil. Hydrogel is used in many fields other than agriculture such as wound dressing, baby diapers and tissue engineering⁵⁻⁹. The essential advantage of using hydrogel is its unique property to absorb and store water¹⁰⁻¹⁴.

2. Experimental Section

2.1. Materials

All chemicals purchased from Sigma Aldrich and used as received.

2.2. Preparation of GGPAAK_m Hydrogels.

1 gm of Guar gum (GG) and 0.5 gm. polyacrylamide (PAA) has been taken in 100 ml of distilled water and kept 2 hrs for stirring. Then, 0.005 g of KMnO₄ which is serving as cross linking agent has been added. Then, the entire mixture was heated either at 60°C on the magnetic stirrer for two hours or micro oven only for two minutes.

3. Results and Discussion

3.1 FTIR

In the case of Guar gum (S-2), the peak at 3285 cm⁻¹ indicates the presence of O-H stretching vibration and peaks observed at 2879 and 1014 cm⁻¹ show C-H stretching and O-H bending vibration, respectively. The peak at 1638 cm⁻¹ was assigned to the stretching vibration of C=O group. But, in the FTIR of polyacrylamide (PAA), the two peaks at 3324.2 and 3178 cm⁻¹

are due to asymmetrical and symmetrical, N-H stretching vibration, respectively and the two C-H stretching vibration such as asymmetrical and symmetrical are found at 2918 and 2853 cm^{-1} , respectively. The strong C=O stretching band and N-H bending are at 1647 and 1599 cm^{-1} , respectively. The peak of C-N stretching vibration appeared at 1430 cm^{-1} . The shifting (either decrease or increase) of old stretching vibration as well as appearance of new vibration in FTIR of GGPAAKm indicates that the crosslinking happened in the GGPAAKm hydrogel. The FTIR of GGPAAKm confirmed that the following vibrational peaks, which is important for absorption of water through hydrogen Bonding. The peak at 3315 cm^{-1} is due to coupled vibration of O-H and N-H whereas peaks at 1655 and 1016 are due to C=O stretching and O-H bending, respectively. The FTIR curve of the GGPAAKm(S-3) and its components can be seen in Fig.3.3.1.

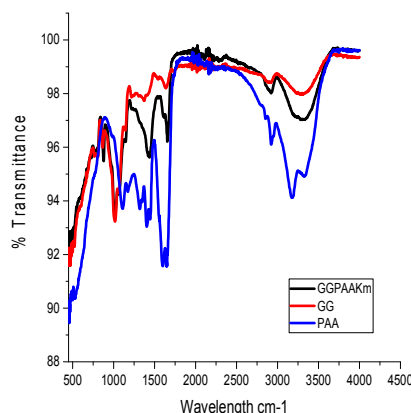
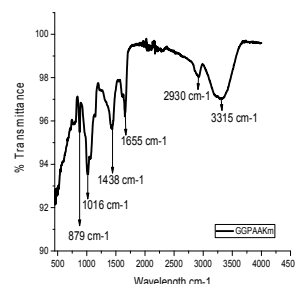
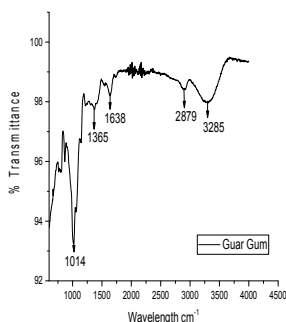
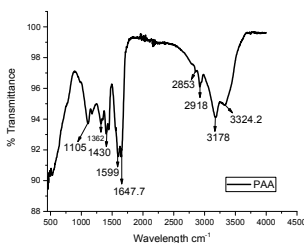


Fig.3.1.1 FTIR



3.2 Scanning electron microscopy (SEM)

The SEM of GGPAAKm confirms the crosslinking which takes place between GG and PAA, can be seen in Fig.3.2 at different magnification. This cross linking structure contained functional groups which make hydrogen bonding with water molecule during absorption. Cross linking structure, make hydrogel insoluble in water, so that hydrogel absorbed water and store water in its three dimensional network and known as water reservoir.

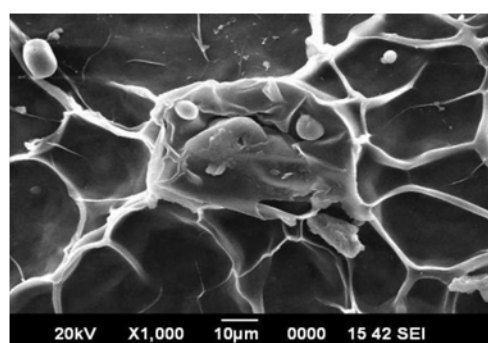
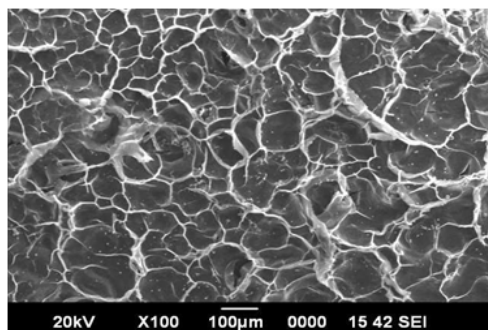
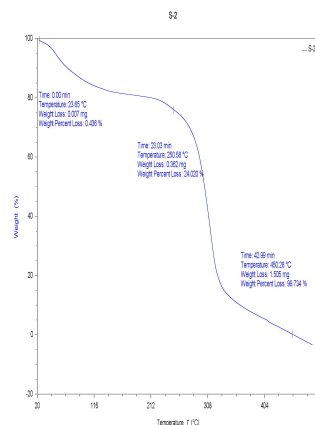


Fig.3.2 SEM of GGPAAKm at different magnification

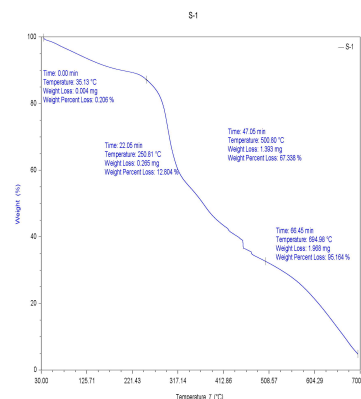
3.3 Thermo-gravimetric Analysis(TGA)

TGA for the new hydrogels was carried out to investigate the effect of cross-linking of PAA on the thermal stability of the GG. TGA for guar gum showed three zones. The first zone at 0-23.65 °C of 0.436 % weight loss is due to evaporation of water. The second zone at 23.65 -250.58°C of 23.584 % weight loss is due to volatile components and moisture. A third zone at 250.58-450.28°C of about 75.714%weight loss is due to 1^o and 2^o O-H alcoholic groups [15-16] and the degradation of backbone chain. But the TGA of GGPAAKm has four decomposition zones, the first zone at 0-35.13°C of 0.206 % weight loss is due to evaporation of water. The second zone at 35.13-250.81°C of 12.598% weight loss is due to volatile components and moisture. The third zone at

250.81-500.80°C of 65.534 % weight loss is due to elimination of side chain. The fourth zone at 500.80-694.98°C of about 28.826% weight loss due to degradation backbone chain. The decomposition of GGPAAKm is less than in comparison to GG, can be confirmed by TGA data and curve(Fig.3.3). TGA curve confirmed that GGPAAKm is more stable than GG, which indicates that cross linking takes place between GG and PAA and this cross- linking make hydrogel stronger than guar Gum.



(a) TGA of GG (S-2)



(b) TGA of GGPAAKm(S-3)

Fig.3.3

3.4 Swelling wt. vs Temperature

The swelling of GGPAAKm in distilled water recorded in Table 3.4 and its curve plotted

in Fig.3.4. The swelling of GGPAAKm in distilled water at 30°C temperature is more than at 60°C.

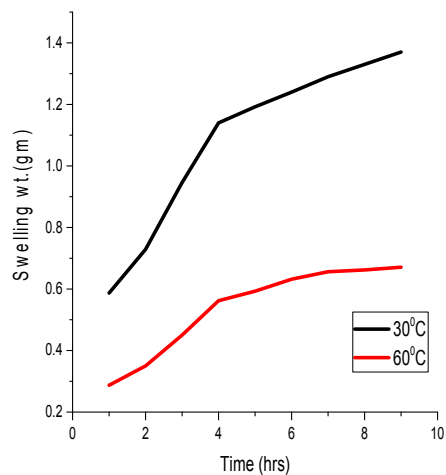
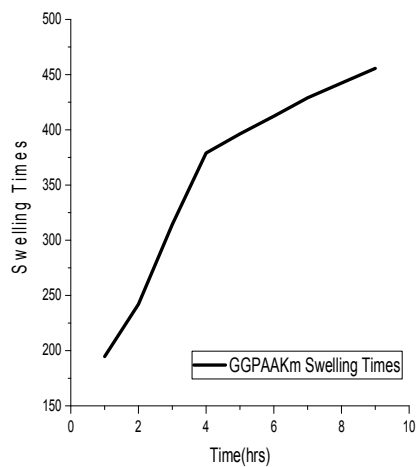
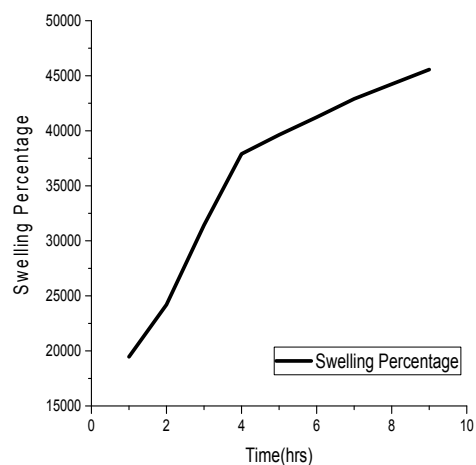
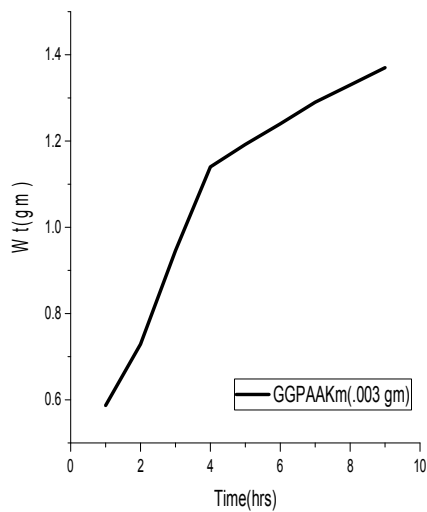


Fig.3.4

Fig.3.4 Swelling in distilled water**Table 3.4**

Time (hrs)	GGPAAKm (.003 gm)	Swelling Times	Swelling Percentage	Temperature (30°C)	Temperature (60 °C)
1	0.587	194.67	19467	0.587	0.287
2	0.729	242.00	24200	0.729	0.350
3	0.946	314.33	31433	0.946	0.450
4	1.140	379.00	37900	1.140	0.562
5	1.192	396.33	39633	1.192	0.593
6	1.240	412.33	41233	1.240	0.632
7	1.290	429.00	42900	1.290	0.656
8	1.330	442.33	44233	1.330	0.662
9	1.370	455.67	45567	1.370	0.671

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