

Biodegradable hydrogel synthesized by Guar Gum

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Abstract : Guar gum-based hydrogel is composed of guar gum, polyacrylamide, and fumaric acid. Because of its ability to store water and release it into the soil as needed by crops, the synthesised hydrogel is used in agriculture. The confirmation of its synthesis is performed by Fourier Transform Infrared Spectroscopy (FTIR), DSC (Differential Scanning Calorimeter), Energy Dispersive X-Ray Spectroscopy (EDS/EDX), and Field Emission Scanning Electron Microscopy (FESEM).

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

Introduction

Crop with good yields and without harmful chemicals could help sustain a large human population in the world. Invention began to synthesize materials that did not produce harmful chemicals and stored water and nutrients that would be released when required by crops. The material developed for this purpose was hydrogel, which could absorb 100 times water in its weight. The chemical selected in this research is biodegradable and contains functional groups that have water-absorbing abilities. Hydrogels have three dimensional networks in which -N-H, -O-H, and C=O group etc. is present that absorb water¹⁻⁵. Hydrogel is used in many fields other than agriculture, such as wound dressing, baby diapers, and tissue engineering⁶⁻¹⁰.

Experimental Section

2.1. Materials

All chemicals purchased from Sigma Aldrich and used as received.

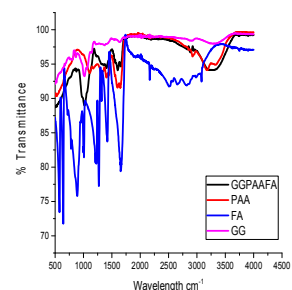
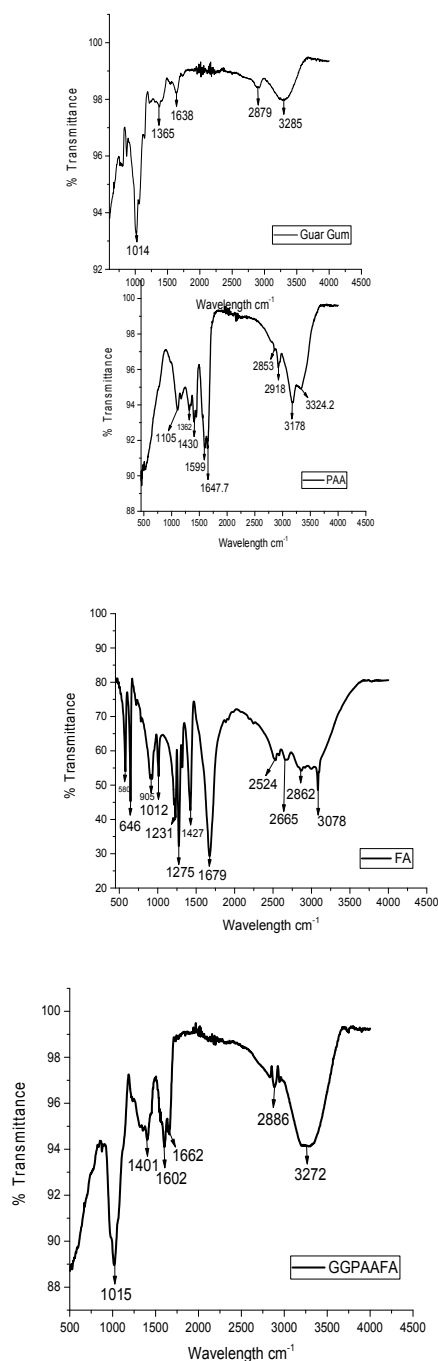
2.2 Preparation of GGPAFA Hydrogel

1 gm of guar gum was mixed in alkaline solution contained fumaric acid and then 0.5 gm of polyacrylamide taken in solution. Then, the entire mixture was heated 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, 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 due to ring stretching. 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. In FTIR of fumaric acid (FA), the peak at 3078 cm⁻¹ is due to unsaturated C-H stretching vibration, the conjugated strong carbonyl stretching band with C=C at 1679 cm⁻¹, hydroxyl stretching (bonded) has several bands: weak bands 2862 cm⁻¹, 2665 cm⁻¹ and 2524 cm⁻¹. The more intense C-O stretching band at 1275 cm⁻¹ and moderate C-O-H bending band at 1427 cm⁻¹. In FTIR of GGPAFA or GGPA hydrogel, the following peaks appeared, 3272, 2886, 1662, 1602, 1401 and 1015 cm⁻¹ respectively, due to O-H, C-H, C=O, N-H, C-O-H and O-H bending,

confirmed the water absorbing ability of hydrogel.



3.2 DSC :

The DSC curve of guar gum confirmed the moisture of guar gum comes out up to 25°C, the melting point of it is 109.13°C and its covalent bond start breaking after 170°C (Fig.3.2 a), but the moisture and some volatile components of GGPAFA come out up to 35°C, glass transition and melting point of it is 46.94°C and 131.33°C and covalent bond start breaking after 225°C, confirmed by DSC curve of GGPAFA (Fig.3.2 b). After comparison of DSC, it confirmed that GGPAFA is more stable than GG.

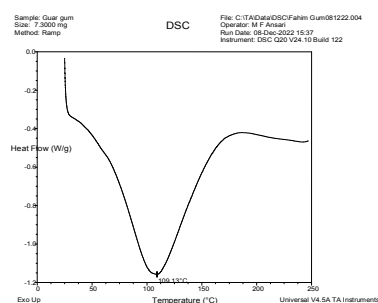


Fig.3.2 (a) DSC of Guar gum

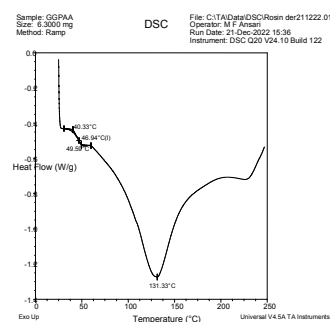


Fig.3.2(b) DSC of GGPAFA

3.3 Energy Dispersive X-Rays Spectroscopy

The Elements and its percentage, which was found in GGTPAAFA, can be confirmed by data obtained by EDS/EDX. The observed data written in Table 3.3 and EDS/EDX curve can be

seen in Fig 3.3. The nitrogen, phosphorous and potassium are essential elements for plant, also present in GGPAFA, confirmed by EDS/EDX data.

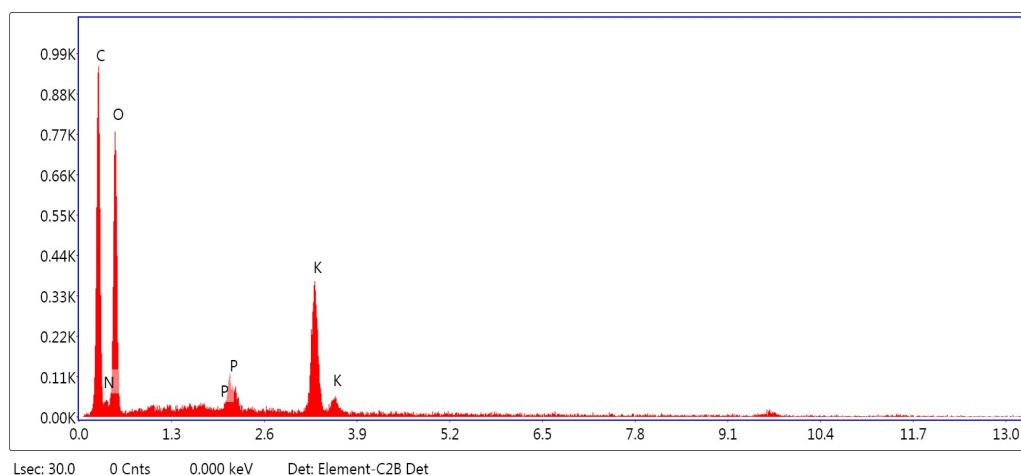


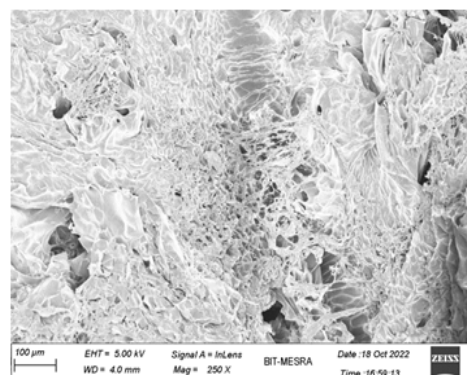
Fig 3.3 EDA/EDX of GGPAFA

Table 3.3 Composition of Elements

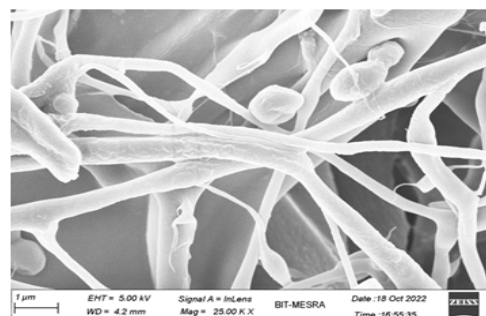
Element	Weight %	Atomic %
Carbon(C)	32.19	41.04
Nitrogen(N)	4.66	5.09
Oxygen(O)	51.41	49.21
Phosphorous(P)	0.54	0.27
Potassium(K)	11.20	4.39

3.4 FESEM

FESEM confirmed the synthesis of GGPAFA, cross-linking that occurred among guar gum, polyacrylamide and fumaric acid, can be seen in Fig. 3.4(a,b) at different magnification. The cross-linking in hydrogel, made it insoluble in water and provided strength to absorb water in its three dimensional network.



(a)



(b) Fig. 3.4 FESEM of GGPAFA

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