

## Ultrasonic and Ftir Studies on Aqueous Biodegradable Polymer Blend Solutions

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**Abstract:** Compatibility of polysaccharide based natural polymer Xanthan gum (Xn), Tragacanth gum (Traga), Acacia gum (Ac) with synthetic polymers viz., poly vinyl pyrrolidone (PVP), polyethylene glycol (PEG) in aqueous solution has been investigated using the related acoustical parameter at room temperature 303K. Consequently the concentration of synthetic polymers PVP and PEG was varied to understand the nature of solute-solvent interaction in the polysaccharide based natural/synthetic polymer in aqueous solution. The FT-IR studies also carried out for vibration assignment and conformation of compatibility.

**Key words:** *Acacia gum · Polyvinyl pyrrolidone · Poly ethylene glycol · Tragacanth gum · Xanthan gum*

### INTRODUCTION

The blending of polymers is one of the simplest means to obtain a variety of physical and chemical properties from the constituent polymers [1]. The gain in newer properties depends on the degree of compatibility or miscibility of the polymer at a molecular level. Hourston and Hughes and Kuleznev have suggested the use of sonic and viscosity measurement for compatibility measurements. Particularly concentration of polysaccharide based natural polymer (Gum Xanthan, Gum tragacanth and Gum Acacia) in aqueous solution was chosen, because changes in the slope of ultrasonic velocity value occur at 0.06% concentration. Another important reason to take-up this problem is, that these polysaccharide based natural polymer are used in the food industry, emulsion stability and viscosity control in Dairy products and Pharmaceutical fields.

### MATERIALS AND METHOD

**Experimental Details:** Gum Xanthan, Gum Acacia and Gum Tragacanth (Nice chemical, Cochin), PVP and PEG (Merck, India). In this work polysaccharide based natural and synthetic polymer used are noted above. The ultrasonic velocity studies were undertaken in natural polymers, Viz, Gum Xanthan, Gum Tragacanth and Gum Acacia, 0.06% concentration of aqueous solution, the synthetic polymer (PEG and PVP) concentration (0.02% to 0.1%) is varied to understand the polysaccharide based natural / synthetic polymer interactions in aqueous

solution. The ultrasonic velocity measurements are made using a continuous wave interferometer operating at a frequency of 5 MHz and at room temperature. Density and viscosity is measured using a specific gravity bottle and an Ostwald viscometer with an accuracy of  $\pm 2$  parts of  $10^4$  and 0.1% respectively. FTIR spectrum was recorded in Nicolet-Avatar 330 Spectrometer available at CISL, Annamalai University in the range of  $4000-400\text{ cm}^{-1}$  using KBr pellet method. The resolution of this instrument is  $\pm 4\text{ cm}^{-1}$  and an accuracy  $\pm 0.01\text{ cm}^{-1}$ . For this work polysaccharide based natural and synthetic polymer take 1:1 weight ratio.

The various physical parameters were calculated from the measured values of density ( $\bar{n}$ ), viscosity ( $\zeta$ ) and ultrasonic velocity (U) using the standard formula [2]

### RESULTS

**Ultrasonic Studies:** The values of ultrasonic velocity, density, viscosity and the other derived acoustical parameters for the aqueous solutions of polysaccharide based natural polymers with PVP and polysaccharide based natural polymers with PEG are shown in Tables 1 and 2. Ultrasonic velocity increases with increases in the concentration of polymer blends. Density and viscosity for polymer blends also increases with increasing concentration. Adiabatic compressibility and intermolecular free length decreases with increase in the concentration. Internal pressure and free volume also increases with increase in the concentration.

Table 1: Ultrasonic velocity and related acoustical parameters in aqueous solution of polysaccharide (0.06%) based natural polymers + PVP blend

Polymer blend	Concentration	U(m s <sup>-1</sup> )	ρ(Kg m <sup>-3</sup> )	η(X 10 <sup>3</sup> ) N s m <sup>-2</sup>	β(X 10 <sup>-10</sup> ) N <sup>-1</sup> m <sup>2</sup>	L <sub>r</sub> (A <sup>o</sup> )	π <sub>i</sub> (X 10 <sup>6</sup> ) pascal	V <sub>f</sub> (X 10 <sup>-6</sup> ) m <sup>3</sup>
Acacia + pvp	0.02	1515	997.75	0.980	4.367	0.417	2.995	0.297
	0.04	1517	999.32	0.984	4.348	0.416	2.978	0.298
	0.06	1520	1000.20	0.989	4.327	0.415	2.984	0.299
	0.08	1524	1000.72	0.994	4.303	0.414	2.989	0.300
	0.10	1527	1001.77	1.009	4.281	0.413	3.011	0.301
Xanthan +pvp	0.02	1514	997.22	1.340	4.375	0.417	3.477	0.297
	0.04	1517	997.92	1.551	4.354	0.416	3.734	0.298
	0.06	1518	998.62	1.664	4.346	0.416	3.869	0.298
	0.08	1520	999.50	2.065	4.330	0.415	4.309	0.299
	0.10	1521	1000.55	2.506	4.320	0.415	4.749	0.299
Tragacanth +pvp	0.02	1510	997.22	1.210	4.398	0.418	3.303	0.296
	0.04	1516	997.92	1.268	4.360	0.417	3.378	0.298
	0.06	1520	998.45	1.315	4.335	0.415	3.436	0.299
	0.08	1522	999.15	1.346	4.321	0.415	3.476	0.299
	0.10	1525	1000.02	1.397	4.300	0.414	3.540	0.300

Table 2: Ultrasonic velocity and Related acoustical parameters in aqueous Solution of polysaccharide (0.06%) based natural polymers + PEG blend

Polymer blend	Concentration	U(m s <sup>-1</sup> )	ρ(Kg m <sup>-3</sup> )	η( X 10 <sup>3</sup> ) N s m <sup>-2</sup>	β( X 10 <sup>-10</sup> ) N <sup>-1</sup> m <sup>2</sup>	L <sub>r</sub> (A <sup>o</sup> )	π <sub>i</sub> (X 10 <sup>6</sup> ) pascal	V <sub>f</sub> (X 10 <sup>-6</sup> ) m <sup>3</sup>
Acacia + PEG	0.02	1515	996.87	0.97	4.371	0.417	2.979	0.294
	0.04	1519	998.45	0.977	4.341	0.416	2.99	0.295
	0.06	1520	998.97	0.988	4.333	0.415	3.007	0.295
	0.08	1523	999.5	1.038	4.313	0.414	3.08	0.296
	0.10	1524	1000.02	1.061	4.305	0.414	3.114	0.296
Tragacanth + PEG	0.02	1518	999.5	1.51	4.342	0.416	3.724	0.295
	0.04	1522	1000.9	1.85	4.313	0.414	4.116	0.296
	0.06	1526	1001.77	1.889	4.287	0.413	4.157	0.297
	0.08	1528	1002.65	2.188	4.272	0.412	4.473	0.298
	0.10	1529	1003.53	2.327	4.262	0.412	4.614	0.298
Xanthan + PEG	0.02	1515	991.62	2.32	4.394	0.418	4.589	0.294
	0.04	1520	993.19	2.631	4.358	0.417	4.887	0.295
	0.06	1522	997.22	3.057	4.329	0.415	5.278	0.296
	0.08	1524	1000.72	3.565	4.302	0.414	5.71	0.297
	0.10	1529	1008.08	4.824	4.243	0.411	6.663	0.298

based natural polymer + PEG blend

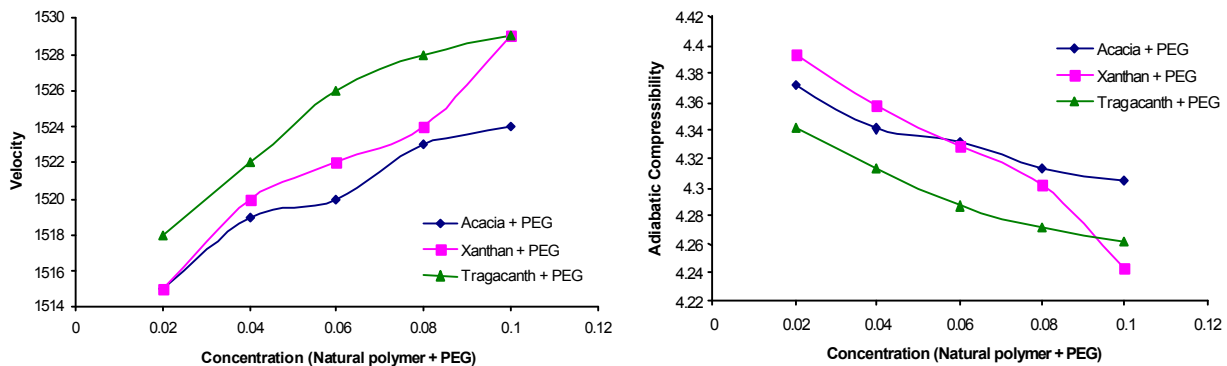


Fig. 1: Ultrasonic velocity and adiabatic compressibility Vs concentration in the aqueous solution of polysaccharide

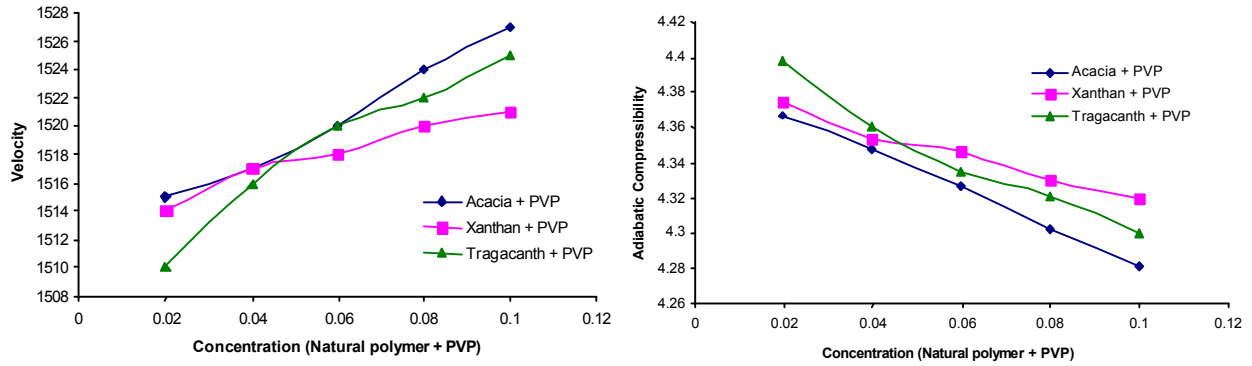


Fig. 2: Ultrasonic velocity and adiabatic compressibility Vs concentration in the aqueous solution of polysaccharide based natural polymer + PVP blend

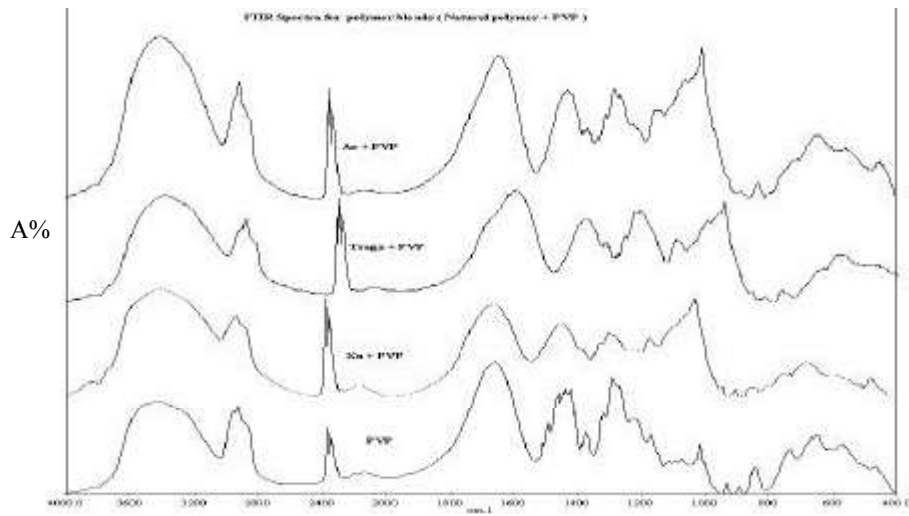


Fig. 3: Overlapped FTIR spectra for polymer blend (Polysaccharide based natural polymer + PVP)

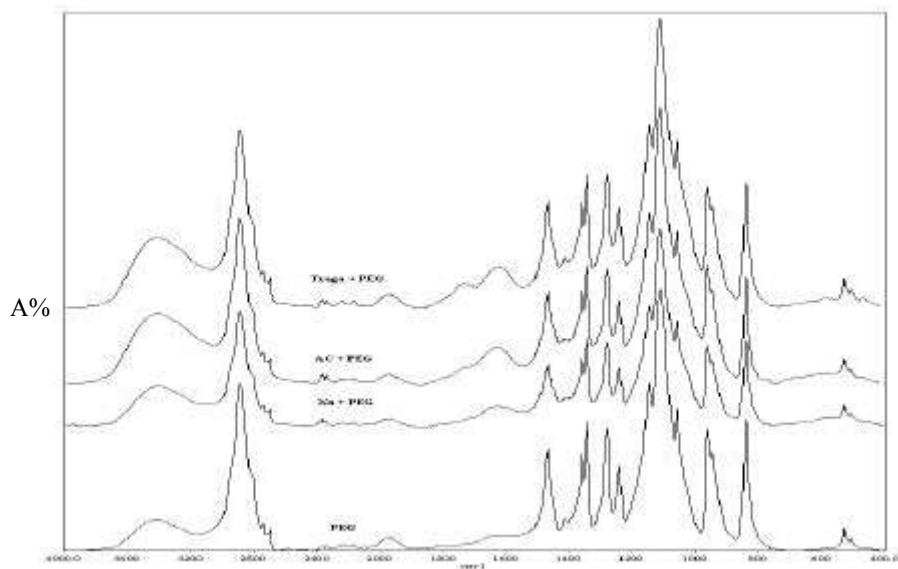


Fig. 4 Overlapped FTIR spectra for polymer blend (Polysaccharide based natural polymer + PEG)

**FI-IR Studies:** Overlap FTIR spectra for polymer blends (polysaccharide based natural polymer + PVP) and (polysaccharide based natural polymer + PEG) shown in Fig. 3 and 4. From the FTIR spectra, the results suggest that Gum Acacia + PVP blend has stronger intermolecular interaction than Gum Xanthan + PVP and Gum Tragacanth + PVP blends. Another case Gum Tragacanth + PEG blend has stronger intermolecular interaction than Gum Acacia + PEG and Gum Xanthan + PEG blends.

## DISCUSSION

From the experimental data the ultrasonic velocity of the polymer blends increases with increasing concentration of synthetic polymers PVP and PEG. The increase in the ultrasonic velocity and decrease in the adiabatic compressibility with increasing the concentration of synthetic polymers is an indication that the intermolecular interaction increases with addition of synthetic polymers in aqueous solution. The interaction may be due to hydrogen bonding between polysaccharide based natural and synthetic polymer [3, 4]. The addition of synthetic polymer lowers the compressibility of the polymer blends due to orientation of the polysaccharide based natural polymer molecules around the synthetic polymer molecule. This has the same effect as the application of an external pressure and the compressibility of water molecules is lowered to an increase in sound velocity. This is also supported by the fact that intermolecular free length is found to decrease with increase in synthetic polymer concentration [5]. The internal pressure increases with increase in the concentration of the synthetic polymer which represents increasing the intermolecular interaction. From the observed ultrasonic velocity and adiabatic compressibility data, the polymer-polymer interaction through hydrogen bonding between the polysaccharide based natural /synthetic polymers exists in the present systems. From this discussion Gum Xanthan + PVP, Gum tragacanth + PVP and Gum Acacia + PVP among these systems Gum Acacia + PVP is better compatible because of that system has stronger intermolecular interaction to compare other system [6]. In the same manner, Gum Xanthan + PEG, Gum Acacia + PEG and Gum tragacanth + PEG among these systems Gum Tragacanth + PEG are better compatible. For further confirmation, FI-IR analysis was also carried out. In the case of Gum Xanthan + PVP blend broadening of bands at  $3413\text{ cm}^{-1}$  and  $1654\text{ cm}^{-1}$  can be attributed to intermolecular hydrogen bonding between Xanthan gum and PVP [7]. In Gum Tragacanth + PVP also broadening of bands at  $3402\text{ cm}^{-1}$  and  $1645\text{ cm}^{-1}$  can be attributed to intermolecular hydrogen bonding between

Gum Tragacanth and PVP. In Gum Acacia + PVP blend broadening of band at  $3420\text{ cm}^{-1}$  and  $1654\text{ cm}^{-1}$  can be attributed to intermolecular hydrogen bonding between Gum Acacia and PVP [8]. In another case Gum Xanthan + PEG, Gum Tragacanth + PEG and Gum Acacia + PEG blends broadening of bands at (about  $3403\text{ cm}^{-1}$  and  $1625\text{ cm}^{-1}$ ) can be attributed to intermolecular hydrogen bonding between natural and synthetic polymers. From the FTIR analysis the result suggests that, among these polymer blends Gum acacia + PVP and Gum Tragacanth + PEG have better compatibility [9].

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