Density and Kinematic Viscosity of Pectin Aqueous Solution[†]

Guilherme C. Guimarães, Marcos C. Coelho Júnior, and Edwin E. Garcia Rojas*

Department of Agribusiness Engineering, Fluminense Federal University, Trabalhadores Av.,
420, 27255-250, Volta Redonda, RJ, Brazil

In this research, we studied the influence of the pH (3.0, 4.0, 5.0, and 6.0), the temperature [(303.1, 308.1, 313.1, and 318.1) K], and the concentration of the pectin [(0.002, 0.004, 0.008, and 0.010) mass fraction] on the density and the kinematic viscosity of aqueous solutions containing low and high metoxilation pectin. The exponential model used to analyze the data of kinematic viscosity was well adjusted to the experimental data with R^2 equal to 0.99 in all of the cases. The data of the density presented a relation with the concentration and an inverse relation with the temperature in all the pH values studied. The lineal model used for correlation density gave a good fit to the experimental data.

Introduction

The knowledge of thermophysics properties (TPP) is a factor of fundamental importance for calculations of engineering that involve the selection and the dimension of equipment related to the processes to transfer heat and/or mass, knowledge of the iteration with the electromagnetic radiation, as well as for the implementation of strategies of control of processes.[1,2]

Empirical models applied to predict TPP of foods are effective in contrast to models derived from theoretical bases.[3,4] Since chemical composition and temperature can strongly affect TPP of foods, these variables are commonly taken into account to develop the above-mentioned mathematical functions.[3−6]

The physical properties of food polysaccharide systems have been widely investigated not only from a scientific point of view to clarify the nature of biopolymers but also from a practical standpoint. Because macroscopic physical properties such as viscosity, density, elasticity, and the thermal properties of food would be essential in an industrial food process, a knowledge of the macroscopic properties of food polysaccharide systems has been accumulated.[7,8] The main polysaccharides used in the industry of foods are alginate, xanthan, agar, carragen, gum-Arabic, and pectin.

The pectin is a natural polysaccharide present in almost all the terrestrial plants and is responsible for structural properties of fruits and vegetables.[9] It is usually extracted from citric fruits and apples. The majority component of the pectin is the galacturonic acid partially esterified with a metoxil group. The pectins can be classified in agreement with the esterified degree (GE): the ones that possess superior GE to 50 % are the high metoxilation pectins (HMP), and the ones with less GE to 50 % are the low metoxilation pectins (LMP).[10−12] An important functional property of this biopolymer is its capacity to form gels in aqueous solutions.[13] Pectins are used largely as an ingredient in the industry of foods, such as in the production of jellies, fruit juices, and sweet shop goods, in the production of eatable biodegradable films,[14] in the separation of proteins,[15] as enantiomers,[16] in the reduction of the cholesterol levels of the human blood,[17,18] and in the reduction of cholesterol in the egg yolk.[19]

The objective of this work was to evaluate its influences of different concentrations, pH, and temperature on the density and kinematic viscosity of aqueous solutions of LMP and HMP.

Experimental

Materials. Aqueous solutions of pectin (α-1,4-linked-D-galacturonic acid), GENU 8002 (GE < 50 %, CP Kelco, Brazil), or GENU 104 (GE > 69 %, CP Kelco, Brazil) with concentrations of (0.002, 0.004, 0.008, and 0.010) mass fraction were prepared using an analytical balance (Tecnal, model B-TEC-210A, Brazil) with a given uncertainty of ± 0.0001 g. The pH of the solutions was adjusted to 3.0, 4.0, 5.0, and 6.0 with buffer solutions (Vetec, Brazil) using a pH meter (Gehaka, PG-100, Brazil) with a precision of ± 0.01. The pH meter was previously calibrated with a buffer solution of 3.0 and 7.0 (Vetec, Brazil). All the experiments were accomplished in temperatures of (303.1, 308.1, 313.1, and 318.1) K. Polynomial regression was performed to adjust the models to the data, and the suitability of the fitted models was evaluated by the coefficient of determination (R^2), the level of significance (p), and residual analysis. The data were correlated using the model proposed in the literature. All of the samples were made in two repetitions, and the experiments were accomplished in duplicate. Statistical analyses were made using the SAS statistical package.[20]

Apparatus and Measuring Procedures. Specific mass (ρ) was determined by using a standard volumetric pycnometer ($\sim$10 cm^3) with a reproducibility of ± 0.001 %. The pycnometer was calibrated using double-distilled water. Calibrated Cannon-Fenske glass capillary viscometers (sizes 50, 75, 100, and 150) were used to measure the kinematic viscosity (ν) (Schott-Geräte, Germany). The viscometers were placed in a water thermostatic bath (Schott-Geräte, CT 53 HT, Germany) for temperature control with a given uncertainty of (± 0.1 K). The standard deviations of the viscosity determinations varied within the range $2.1 \cdot 10^{-7}$ m$^2 \cdot$s^{-1} to

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* Corresponding author. Tel.: +55 24 33443027. Fax: +55 24 33443019. E-mail: edwin@vm.uff.br.

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Table 1. Density, ρ, and Viscosity, ν, for the Systems with High Metoxilation Pectin (1) + Water (3) from T = (303.1 to 318.1) K and pH = 3.0 to 6.0[a]

				ρ_{1+3}	$\nu_{1+3}\cdot 10^6$
pH	T/K	w_1	w_3	$\mathrm{kg\cdot m^{-3}}$	$\mathrm{m^2\cdot s^{-1}}$
3.0	303.1	0.002	0.998	999.593 ± 0.085	1.558 ± 0.006
	308.1	0.002	0.998	998.582 ± 0.169	1.402 ± 0.004
	313.1	0.002	0.998	997.223 ± 0.007	1.259 ± 0.019
	318.1	0.002	0.998	996.363 ± 0.198	1.134 ± 0.018
	303.1	0.004	0.996	999.788 ± 0.263	2.714 ± 0.027
	308.1	0.004	0.996	998.972 ± 0.141	2.390 ± 0.023
	313.1	0.004	0.996	998.095 ± 0.037	2.108 ± 0.020
	318.1	0.004	0.996	996.582 ± 0.232	1.882 ± 0.013
	303.1	0.008	0.992	1002.126 ± 0.117	6.374 ± 0.020
	308.1	0.008	0.992	1001.164 ± 0.235	5.543 ± 0.090
	313.1	0.008	0.992	999.906 ± 0.145	4.777 ± 0.126
	318.1	0.008	0.992	998.230 ± 0.240	4.181 ± 0.110
	303.1	0.010	0.990	1002.524 ± 0.187	9.310 ± 0.130
	308.1	0.010	0.990	1001.833 ± 0.123	8.005 ± 0.105
	313.1	0.010	0.990	1000.645 ± 0.081	6.895 ± 0.090
	318.1	0.010	0.990	999.349 ± 0.035	6.005 ± 0.078
4.0	303.1	0.002	0.998	999.240 ± 0.165	1.545 ± 0.066
	308.1	0.002	0.998	998.233 ± 0.066	1.383 ± 0.057
	313.1	0.002	0.998	997.144 ± 0.091	1.278 ± 0.012
	318.1	0.002	0.998	996.472 ± 0.045	1.152 ± 0.017
	303.1	0.004	0.996	1000.095 ± 0.147	2.617 ± 0.034
	308.1	0.004	0.996	999.562 ± 0.088	2.313 ± 0.027
	313.1	0.004	0.996	998.206 ± 0.258	2.055 ± 0.020
	318.1	0.004	0.996	997.651 ± 0.038	1.836 ± 0.018
	303.1	0.008	0.992	1003.055 ± 0.110	6.072 ± 0.153
	308.1	0.008	0.992	1002.058 ± 0.018	5.203 ± 0.017
	313.1	0.008	0.992	1001.293 ± 0.090	4.534 ± 0.025
	318.1	0.008	0.992	1000.447 ± 0.104	3.969 ± 0.043
	303.1	0.010	0.990	1004.145 ± 0.035	8.619 ± 0.038
	308.1	0.010	0.990	1003.043 ± 0.202	7.486 ± 0.056
	313.1	0.010	0.990	1002.517 ± 0.037	6.534 ± 0.013
	318.1	0.010	0.990	1001.663 ± 0.046	5.720 ± 0.011
5.0	303.1	0.002	0.998	1005.556 ± 0.114	1.532 ± 0.001
	308.1	0.002	0.998	1004.456 ± 0.036	1.370 ± 0.001
	313.1	0.002	0.998	1003.350 ± 0.044	1.232 ± 0.001
	318.1	0.002	0.998	1002.250 ± 0.122	1.116 ± 0.002
	303.1	0.004	0.996	1006.496 ± 0.233	2.402 ± 0.019
	308.1	0.004	0.996	1005.,392 ± 0.153	2.138 ± 0.011
	313.1	0.004	0.996	1004.293 ± 0.076	1.905 ± 0.012
	318.1	0.004	0.996	1003.197 ± 0.002	1.708 ± 0.013
	303.1	0.008	0.992	1007.076 ± 0.446	5.312 ± 0.018
	308.1	0.008	0.992	1006.171 ± 0.385	4.656 ± 0.013
	313.1	0.008	0.992	1005.270 ± 0.322	4.088 ± 0.010
	318.1	0.008	0.992	1004.477 ± 0.182	3.615 ± 0.014
	303.1	0.010	0.990	1008.646 ± 0.118	7.650 ± 0.006
	308.1	0.010	0.990	1007.740 ± 0.179	6.636 ± 0.059
	313.1	0.010	0.990	1006.867 ± 0.261	5.805 ± 0.062
	318.1	0.010	0.990	1005.967 ± 0.326	5.096 ± 0.052
6.0	303.1	0.002	0.998	1001.460 ± 0.215	1.521 ± 0.037
	308.1	0.002	0.998	1000.690 ± 0.082	1.360 ± 0.031
	313.1	0.002	0.998	999.565 ± 0.199	1.220 ± 0.023
	318.1	0.002	0.998	998.620 ± 0.189	1.102 ± 0.014
	303.1	0.004	0.996	1002.868 ± 0.212	2.427 ± 0.023
	308.1	0.004	0.996	1001.855 ± 0.173	2.153 ± 0.024
	313.1	0.004	0.996	1000.775 ± 0.088	1.909 ± 0.010
	318.1	0.004	0.996	999.878 ± 0.132	1.702 ± 0.003
	303.1	0.008	0.992	1004.397 ± 0.158	5.327 ± 0.061
	308.1	0.008	0.992	1003.598 ± 0.272	4.660 ± 0.014
	313.1	0.008	0.992	1002.979 ± 0.512	4.090 ± 0.018
	318.1	0.008	0.992	1001.276 ± 0.013	3.614 ± 0.018
	303.1	0.010	0.990	1004.425 ± 0.188	7.362 ± 0.291
	308.1	0.010	0.990	1003.710 ± 0.216	6.438 ± 0.213
	313.1	0.010	0.990	1003.063 ± 0.004	5.617 ± 0.172
	318.1	0.010	0.990	1001.746 ± 0.248	4.930 ± 0.156

[a] w_1 = mass fraction of high metoxilation pectin. w_3 = mass fraction of water.

$1.1\cdot 10^{-9}\ \mathrm{m^2\cdot s^{-1}}$. The coefficient of variation of the experimental measurements can be estimated as being not higher than 5.0 %.

Table 2. Density, ρ, and Viscosity, ν, for the Systems with Low Metoxilation Pectin (2) + Water (3) from T = (303.1 to 318.1) K and pH = 3.0 to 6.0[a]

				ρ_{2+3}	$\nu_{2+3}\cdot 10^6$
pH	T/K	w_2	w_3	$\mathrm{kg\cdot m^{-3}}$	$\mathrm{m^2\cdot s^{-1}}$
3.0	303.1	0.002	0.998	999.726 ± 0.098	1.447 ± 0.001
	308.1	0.002	0.998	999.157 ± 0.397	1.275 ± 0.003
	313.1	0.002	0.998	997.449 ± 0.108	1.138 ± 0.003
	318.1	0.002	0.998	996.575 ± 0.024	1.027 ± 0.001
	303.1	0.004	0.996	1000.422 ± 0.192	2.217 ± 0.055
	308.1	0.004	0.996	999.441 ± 0.184	1.917 ± 0.043
	313.1	0.004	0.996	998.465 ± 0.172	1.680 ± 0.033
	318.1	0.004	0.996	997.573 ± 0.101	1.500 ± 0.026
	303.1	0.008	0.992	1002.875 ± 0.024	4.700 ± 0.200
	308.1	0.008	0.992	1002.100 ± 0.129	3.963 ± 0.131
	313.1	0.008	0.992	1001.177 ± 0.178	3.411 ± 0.104
	318.1	0.008	0.992	1000.239 ± 0.116	2.993 ± 0.094
	303.1	0.010	0.990	1004.023 ± 0.004	6.437 ± 0.136
	308.1	0.010	0.990	1002.887 ± 0.097	5.384 ± 0.109
	313.1	0.010	0.990	1001.965 ± 0.047	4.619 ± 0.081
	318.1	0.010	0.990	1000.938 ± 0.072	4.032 ± 0.068
4.0	303.1	0.002	0.998	1000.594 ± 0.067	1.374 ± 0.020
	308.1	0.002	0.998	1000.031 ± 0.276	1.236 ± 0.021
	313.1	0.002	0.998	998.632 ± 0.105	1.117 ± 0.018
	318.1	0.002	0.998	997.937 ± 0.010	1.014 ± 0.017
	303.1	0.004	0.996	1001.221 ± 0.056	2.061 ± 0.019
	308.1	0.004	0.996	1000.313 ± 0.091	1.841 ± 0.014
	313.1	0.004	0.996	999.375 ± 0.147	1.648 ± 0.010
	318.1	0.004	0.996	998.703 ± 0.015	1.485 ± 0.010
	303.1	0.008	0.992	1003.003 ± 0.070	4.130 ± 0.030
	308.1	0.008	0.992	1001.898 ± 0.104	3.641 ± 0.022
	313.1	0.008	0.992	1001.140 ± 0.032	3.222 ± 0.020
	318.1	0.008	0.992	1000.328 ± 0.001	2.867 ± 0.021
	303.1	0.010	0.990	1003.642 ± 0.044	5.670 ± 0.111
	308.1	0.010	0.990	1002.795 ± 0.036	4.958 ± 0.098
	313.1	0.010	0.990	1002.106 ± 0.083	4.374 ± 0.080
	318.1	0.010	0.990	1001.304 ± 0.124	3.875 ± 0.060
5.0	303.1	0.002	0.998	1003.192 ± 0.016	1.363 ± 0.016
	308.1	0.002	0.998	1002.023 ± 0.048	1.223 ± 0.016
	313.1	0.002	0.998	1001.086 ± 0.049	1.103 ± 0.015
	318.1	0.002	0.998	1000.161 ± 0.156	1.001 ± 0.014
	303.1	0.004	0.996	1003.995 ± 0.002	2.071 ± 0.020
	308.1	0.004	0.996	1002.687 ± 0.166	1.848 ± 0.017
	313.1	0.004	0.996	1001.762 ± 0.059	1.655 ± 0.013
	318.1	0.004	0.996	1000.811 ± 0.029	1.504 ± 0.027
	303.1	0.008	0.992	1005.439 ± 0.156	4.178 ± 0.198
	308.1	0.008	0.992	1004.488 ± 0.066	3.677 ± 0.159
	313.1	0.008	0.992	1003.553 ± 0.033	3.255 ± 0.132
	318.1	0.008	0.992	1002.562 ± 0.094	2.900 ± 0.114
	303.1	0.010	0.990	1006.575 ± 0.060	5.519 ± 0.005
	308.1	0.010	0.990	1005.861 ± 0.116	4.838 ± 0.011
	313.1	0.010	0.990	1004.557 ± 0.156	4.260 ± 0.021
	318.1	0.010	0.990	1002.676 ± 0.411	3.778 ± 0.030
6.0	303.1	0.002	0.998	1007.054 ± 0.206	1.356 ± 0.013
	308.1	0.002	0.998	1006.559 ± 0.069	1.216 ± 0.015
	313.1	0.002	0.998	1005.702 ± 0.088	1.098 ± 0.015
	318.1	0.002	0.998	1004.722 ± 0.021	0.997 ± 0.013
	303.1	0.004	0.996	1008.178 ± 0.080	2.015 ± 0.050
	308.1	0.004	0.996	1007.231 ± 0.036	1.800 ± 0.055
	313.1	0.004	0.996	1006.298 ± 0.001	1.610 ± 0.049
	318.1	0.004	0.996	1005.344 ± 0.046	1.451 ± 0.046
	303.1	0.008	0.992	1009.482 ± 0.014	4.000 ± 0.052
	308.1	0.008	0.992	1008.662 ± 0.031	3.518 ± 0.056
	313.1	0.008	0.992	1007.688 ± 0.031	3.117 ± 0.047
	318.1	0.008	0.992	1006.716 ± 0.092	2.779 ± 0.040
	303.1	0.010	0.990	1010.182 ± 0.027	5.518 ± 0.012
	308.1	0.010	0.990	1009.436 ± 0.070	4.842 ± 0.024
	313.1	0.010	0.990	1008.490 ± 0.027	4.264 ± 0.027
	318.1	0.010	0.990	1007.554 ± 0.008	3.783 ± 0.020

[a] w_2 = mass fraction of low metoxilation pectin. w_3 = mass fraction of water.

Results and Discussion

Tables 1 and 2 show the experimental results of viscosity LMP and HMP for different temperatures, pH, and concentra-

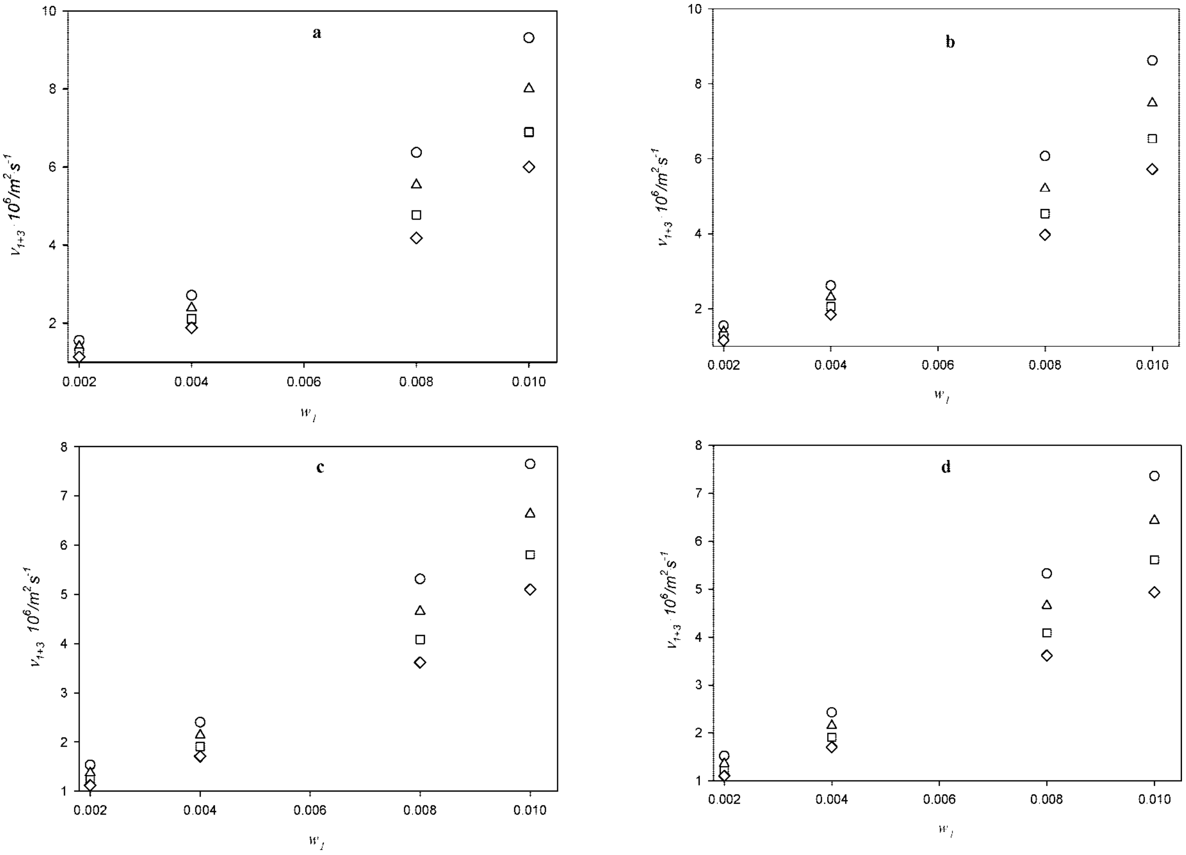

Figure 1. Kinematic viscosity ν of systems with high metoxilation pectin (1) + water (3) as a function of mass fraction of high metoxilation pectin w_1: ○, 303.1 K; △, 308.1 K; □, 313.1 K; ◇, 318.1 K; a, pH 3.0; b, pH 4.0; c, pH 5.0; d, pH 6.0.

Table 3. Parameter Values Used in Equation 1[a] for the Systems with Low Metoxilation Pectin and Water

pH	P_1	P_2	P_3	P_4	R^2	AAD (%)	SD ($mm^2 \cdot s^{-1}$)
3.0	0.0630	365.98	235.01	−99.62	0.99	2.74	0.09
4.0	0.1055	311.13	242.17	−108.49	0.99	2.34	0.06
5.0	0.1049	315.73	235.35	−108.40	0.99	3.72	0.11
6.0	0.0193	815.21	355.96	−176.78	0.99	1.79	0.04

[a] Equation 1: $\nu \cdot 10^6 = P_1 \cdot \exp(P_2 + P_3 \cdot w_2/T/\mathrm{K} - P_4)$. AAD = Average absolute deviation. SD = Standard deviation.

Table 4. Parameter Values Used in Equation 1[a] for the Systems with High Metoxilation Pectin and Water

pH	P_1	P_2	P_3	P_4	R^2	AAD (%)	SD ($mm^2 \cdot s^{-1}$)
3	0.14	267.28	270.49	−96.64	0.99	4.37	0.14
4	0.08	406.39	311.79	−121.51	0.99	3.63	0.13
5	0.03	730.83	381.58	−164.52	0.99	2.25	0.07
6	0.14	259.80	246.93	−98.31	0.99	4.06	0.13

[a] Equation 1: $\nu \cdot 10^6 = P_1 \cdot \exp(P_2 + P_3 \cdot w_1/T/\mathrm{K} - P_4)$. AAD = Average absolute deviation. SD = Standard deviation.

Table 5. Parameter Values Used in Equation 4[a] for the Systems with High Metoxilation Pectin and Water

pH	a	b	c	AAD (%)	R^2	SD ($kg \cdot m^{-3}$)
3.0	1067	414.6	−0.22	0.02	0.98	0.27
4.0	1050	648.7	−0.17	0.01	0.99	0.18
5.0	1065	385.4	−0.19	0.03	0.96	0.35
6.0	1059	401.1	−0.19	0.03	0.96	0.36

[a] Equation 4: $\rho = a + b \cdot w_1 + c \cdot T$. AAD = Average absolute deviation. SD = Standard deviation.

Table 6. Parameter Values Used in Equation 4[a] for the Systems with Low Metoxilation Pectin and Water

pH	a	b	c	AAD (%)	R^2	SD ($kg \cdot m^{-3}$)
3.0	1059	553.8	−0.19	0.02	0.98	0.24
4.0	1052	400.8	−0.17	0.01	0.99	0.16
5.0	1068	415.0	−0.21	0.02	0.98	0.24
6.0	1060	359.3	−0.17	0.01	0.99	0.11

[a] Equation 4: $\rho = a + b \cdot w_2 + c \cdot T$. AAD = Average absolute deviation. SD = Standard deviation.

tion. When the solution is heated, the viscosity decreases as the thermal energy of the molecules increases, and the intermolecular distances increase due to thermal expansion. As seen from Table 1, at higher temperature viscosity decreases, and at higher concentration viscosity increases, which is in accordance with the literature.[21−25] The effect of temperature was stronger at the higher concentration. The viscosity of pectin increased with the increase of pectin concentration in all temperatures and pH values. When the solid concentration increases, the viscosity increases because of the increase in hydrogen bonding with hydroxyl groups and the distortion in the velocity pattern of the liquid by hydrated molecules of the solute. The intermolecular distance is also a factor that affects the viscosity inversely proportional to it due to changing temperatures.[24] The pH of the solution also influenced the behavior of the viscosity. It is noticed that the tendency is that aqueous solutions of pectin of more acidic pH present a larger viscosity in relation to the other pH studied, and this is due to the increment of the hydrophobic interactions of the estermethyl groups ($COOCH_3$), whose hydrophobic interactions sustain the structure of the gel.[26]

Equation 1 was adjusted to the observed data to correlate the viscosity as a function of temperature and mass fraction of each value of the pH studied. This equation, proposed by Gonzales-Tello et al.,[27] has been used to correlate the viscosity of polymeric solutions and gave a good fit to the experimental data, as observed in Figures 1. A determination coefficient $R^2 \geq 0.99$ in all of the studied cases was obtained

$$\nu\cdot 10^6 = P_1\cdot \exp\left(\frac{P_2 + P_3\cdot w}{T/\mathrm{K} - P_4}\right) \qquad (1)$$

where ν it is the kinematic viscosity of the solution; w is the mass fraction of LMP or HMP; and T is the temperature of the

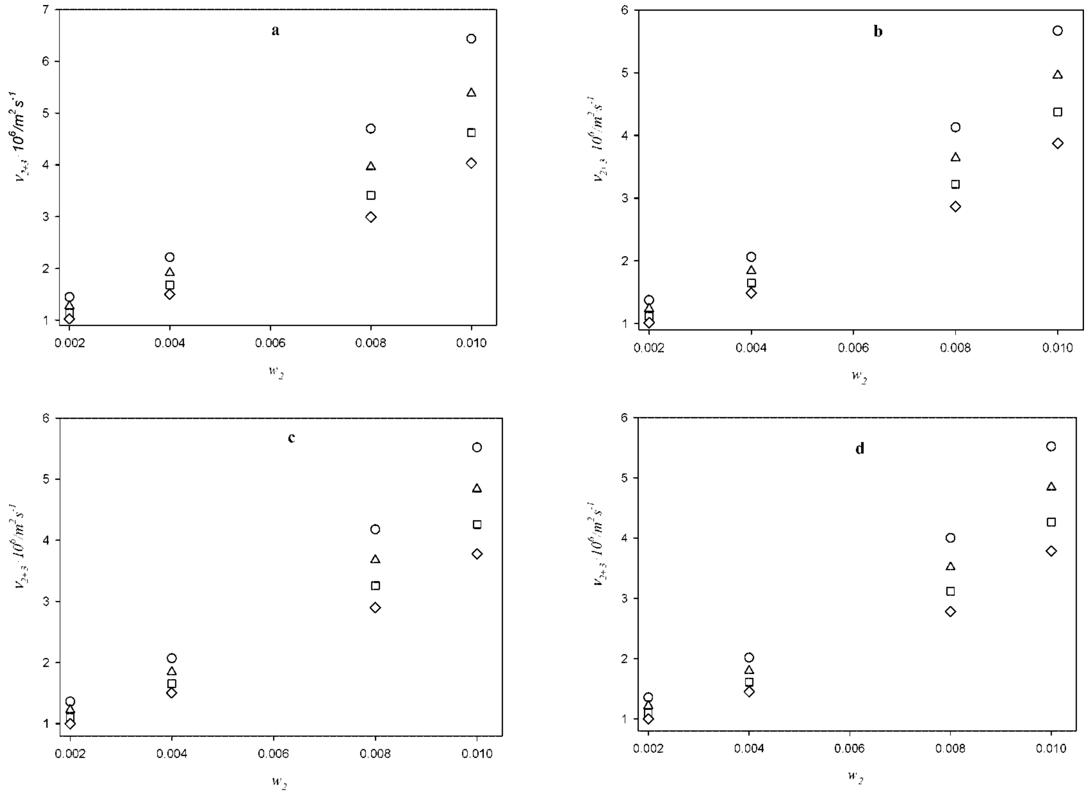

Figure 2. Kinematic viscosity ν of systems with low metoxilation pectin (2) + water (3) as a function of mass fraction of low metoxilation pectin w_2: ○, 303.1 K; Δ, 308.1 K; □, 313.1 K; ◇, 318.1 K; a, pH 3.0; b, pH 4.0; c, pH 5.0; d, pH 6.0.

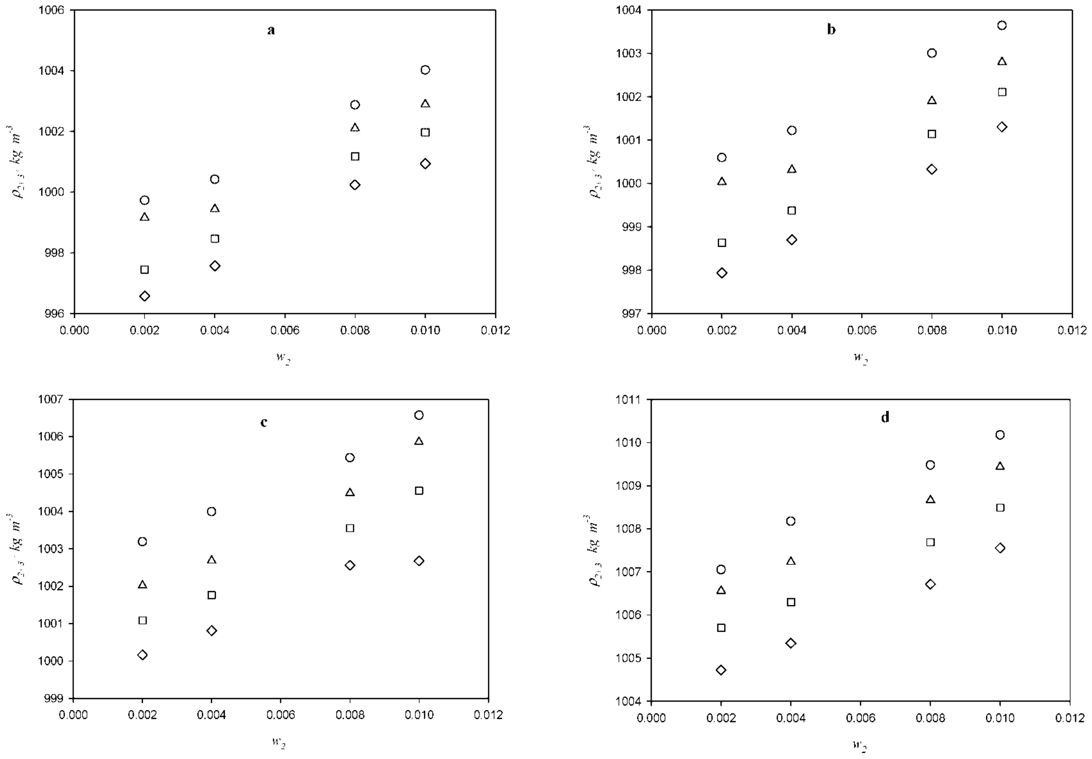

Figure 3. Density ρ of systems with low metoxilation pectin (2) + water (3) as a function of mass fraction of low metoxilation pectin w_2: ○, 303.1 K; Δ, 308.1 K; □, 313.1 K; ◇, 318.1 K; a, pH 3.0; b, pH 4.0; c, pH 5.0; d, pH 6.0.

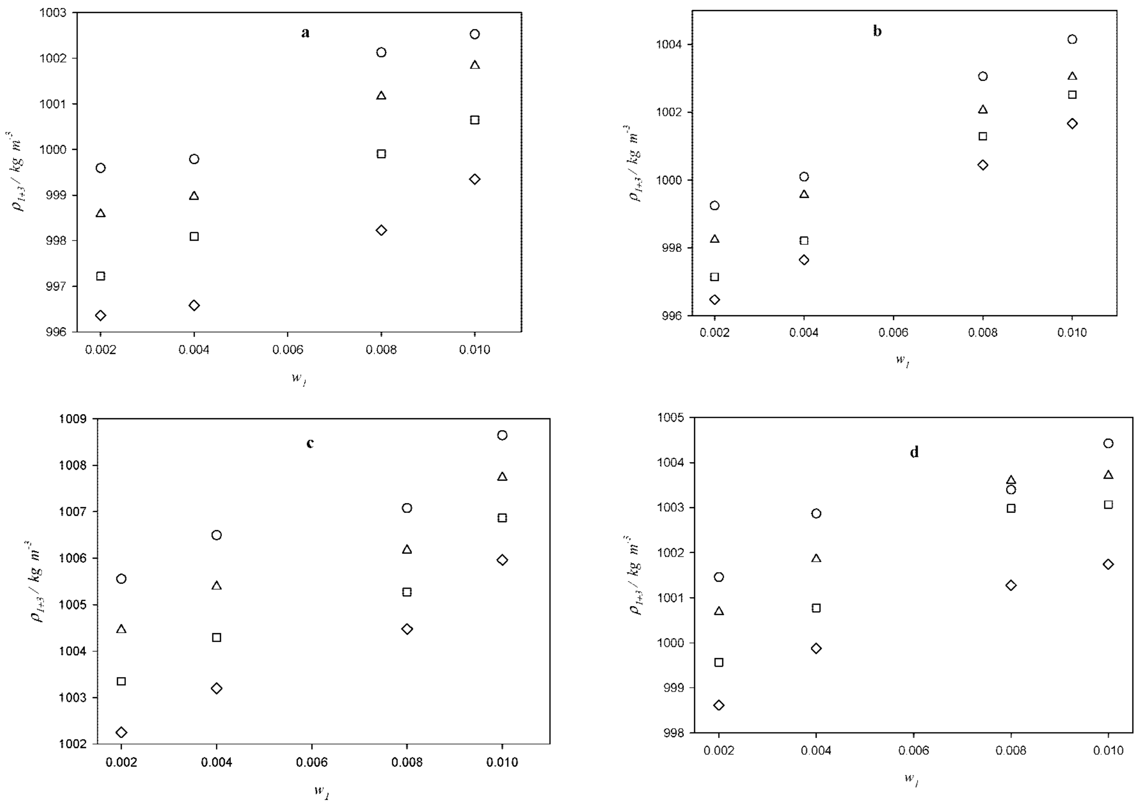

Figure 4. Density ρ of systems with high metoxilation pectin (2) + water (3) as a function of mass fraction of high metoxilation pectin w_1: ○, 303.1 K; Δ, 308.1 K; □, 313.1 K; ◇, 318.1 K; a, pH 3.0; b, pH 4.0; c, pH 5.0; d, pH 6.0.

system. P_1, P_2, P_3, and P_4 were obtained by nonlinear regression. In Tables 3 and 4, the values of these parameters are listed, as well as the values of the standard deviation (SD) and average absolute deviation (AAD), calculated in agreement with eqs 2 and 3, respectively.[28] The results of SD and AAD were inferior to 0.14 $\text{mm}^2\cdot\text{s}^{-1}$ and 3.72 %, respectively, which is indicative of goodness of fit.

$$\text{SD} = \left[\frac{\sum_{i=1}^{m}(\eta_{\text{exp},1} - \eta_{\text{cal},1})^2}{(m-p)}\right]^{0.5} \tag{2}$$

$$\text{AAD} = \left[\sum_{i=1}^{m}\left(\frac{|\eta_{\text{exp},i} - \eta_{\text{cal},i}|}{\eta_{\text{exp},i}}\right)\right]\cdot\frac{100}{m} \tag{3}$$

The experimental data of the density are presented in Tables 1 and 2. The mathematical lineal model (eq 4) was well adjusted to the experimental data as observed in Figures 3 and 4. A determination coefficient $R^2 \geq 0.96$ was obtained in all of the studied cases. The results of SD and AAD were inferior to 0.36 $\text{kg}\cdot\text{m}^{-3}$ and 0.03 %, respectively. This is indicative of a good fit to the experimental data.

$$\rho = a + b\cdot w + c\cdot T \tag{4}$$

where a, b, and c are constants determined by lineal regression for each value studied in pH. In Tables 5 and 6 are listed the values of these parameters, for HMP and for LMP, respectively.

In Table 1, the relation of the density of the solutions of HMP is presented with the studied variables (temperature, concentration, and pH) where it can be observed that the temperature presented a relation inversely proportional to the density, while the concentration had a reaction directly proportional. In relation to the pH, an increment of the density can be observed in the studied extreme pHs (3.0 and 6.0).

Conclusions

In this work, we studied the influence of the pH (3.0, 4.0, 5.0, and 6.0), the temperature [(303.1, 308.1, 313.1, and 318.1) K], and the concentration of the pectin [(0.002, 0.004, 0.008, and 0.010) mass fraction] on the density and the kinematic viscosity of aqueous solutions containing low and high metoxilation pectin. The exponential model applied to analyze the data of kinematic viscosity was well adjusted to the experimental data with R^2 equal to 0.99 in all of the cases. The data of the density presented a direct relation with the concentration and an inverse relation with the temperature in all the pH values studied. The lineal model used for correlation density gave a good fit to the experimental data.

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