Proceedings of IMECE2002
ASME International Mechanical Engineering Congress & Exposition
November 17–22, 2002, New Orleans, Louisiana

IMECE2002-32195

EFFECT OF MESQUITE SEED GUM ON THE RHEOLOGICAL PROPERTIES OF MIXTURES WITH ARABIC AND GELLAN GUMS

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ABSTRACT

The mesquite seed gum (*Prosopis sp.)* represents an alternative application in the food industry, due to its structural likeness with other galactomannans used at the moment. The information about the properties of mesquite seed gum is scarce, for this is important to known the rheological properties of this biopolymer and its interactions with other polymers for seeing future applications. The aim of this work was study the rheological behavior of mesquite seed gum and their effects in arabic and gellan gum mixtures. They were prepared aqueous dispersions according to a Simplex-Centroid design, being obtained gum combinations of total concentration of 1% from mesquite-arabic, mesquite-gellan, arabic-gellan and mesquite-arabic-gellan, the pH from the dispersions were adjusted to 4, 5 and 6. The mixtures as well as the individual biopolymers were dispersed to ambient temperature, and later heated during 20 minutes at 90 °C and cooling at 25 °C. The rheological studies were made using an Haake RV2 viscometer. The statistical analysis showed differences (α = 0.05) among the rheologic value for mixtures at different pH. The mixtures showed a non-Newtonian behavior, type pseudoplastic flow (shear thinning) and showed high viscosities to low shears rates (100 s^{-1}) in all the cases. The tendency of mixtures with two or three components showed an antagonistic effect in the viscosity. Particularly the mesquite seed gum suffers an antagonistic effect in the viscosity when it was mixed with the arabic and gellan gums, being observed decreases from a 8 until 45%, below the control.

INTRODUCTION

The viscosity and thickening properties of galactomannan from leguminosae have found many applications in food, cosmetics, and pharmaceutics industry. Synergistic polysaccharide-polysaccharide interactions are attractive and improve the technological applications [3].

Mesquite seed gum is a galactomannan extracted from the endosperm layer of the *Prosopis* seeds [1]. This gum increases significantly the viscosity of the solutions or dispersions where it is used, the dispersions has translucent to opaque white color depending on the concentration. Some galactomannans present high synergistic interactions when mixed with other polysaccharides (xanthan and locust been gum). Physical interactions between galactomannans and xanthana gum and kappa- carrageenan had been studied but other polysaccharides such as gellan and arabic gums had not been studied. Therefore, the aim of the present investigation was to characterizes the effect of mesquite seed gum on the rheological behavior in gellan and arabic systems.

NOMENCLATURE

A = arabic gum
G = gellan gum
M = mesquite seed gum
α = statistically significant difference

MATERIALS AND METHODS

MATERIALS

Comercial arabic gum (food grade) was supplied by Farmacias Paris (México), gellan gum (Kelcogel F) by Kelco Biopolymers and mesquite seed gum. Mesquite seed gum (*Prosopis sp.*) was extracted using the procedure was described by Ramos-Ramírez, *et al* [6].

The aqueous dispersions were prepared according to Simplex-Centroid design. In the table 1 it is showed the concentrations for each mixture.

METHODS

Preparation of dispersions

The samples were dispersed in water under moderate agitation for 1 hr, at room temperature, and then heated at 90 °C for 30 min with starring. The total polymer concentration was 1% for all the samples and the rheological measurements were done the pH at 4, 5 and 6 values.

Rheological behavior

Once adjusted the pH in the polymers mixtures the flow behavior were characterized at 25 °C, in a Haake model RV2 with a system of concentric cylinders and a geometry SV1. Each sample was analyzed by triplicate.

Table 1. Experimental design for polymer mixtures.

Experiment	*Mixed systems*	*Polysaccharides*		
		Arabic [%]	gellan [%]	mesquite [%]
1	A1	1	0	0
2	G2	0	1	0
3	M3	0	0	1
4	GA4	0.5	0.5	0
5	AM5	0.5	0	0.5
6	GG6	0	0.5	0.5
7	AGM7	0.333	0.333	0.333
8	AGM8	0.660	0.166	0.166
9	AGM9	0.166	0.660	0.166
10	AGM10	0.166	0.166	0.660

RESULTS AND DISCUSSION

The rheological behavior of the mesquite seed gum, gellan and arabic gum is non-Newtonian, pseudoplastic type, (fig. 1).

Also the rheological behavior for mixtures was non–Newtonian, pseudoplastic type, (fig.1), consequently, the viscosity of these dispersions was apparent since it changed with shear rate. Viscosity of the dispersions of individual gums was higher to gellan an mesquite seed gum than the viscosity of these mixtures. The antagonic effect was observed in the mixtures with high arabic gum concentration: AG4 and AGM8. The mixtures with high mesquite seed gum concentration (GM6 and AGM10) showed high viscosity than mixtures with low mesquite seed gum concentrations (fig 1,2 and 3). Mixtures with high arabic gum concentration showed antagonic effect on the viscosity. The behavior shown is typically observed for dilute polymer dispersions, derives from conformational changes induced on the polymer by the shear. The high viscosity observed at low shear rates was a contribution from interactions between polymer chains. At high shear rates many inter-polymer bonds are broken enabling to a significant shear thinning. The lower viscosity at high shear rates then two effects derives: the reduced effective hydrodinamic radius of the polymer coil and the reduced interactions between the polymers.

By other hand the interaction among galactomannans with themselves, or with other polysaccharides, are enhanced by the distribution of galactose ramifications. These distribution are not constant, there are zones without ramifications (smooth region) [4].

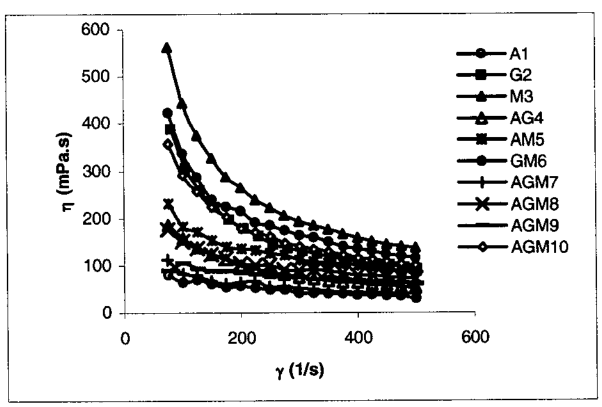

Fig 1. Apparent viscosity (η) vs shear rate (γ) at pH 4.

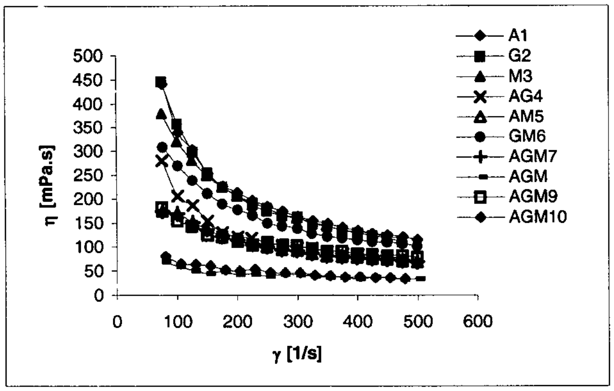

Fig 2. Apparent viscosity (η) vs shear rate (γ) at pH 5.

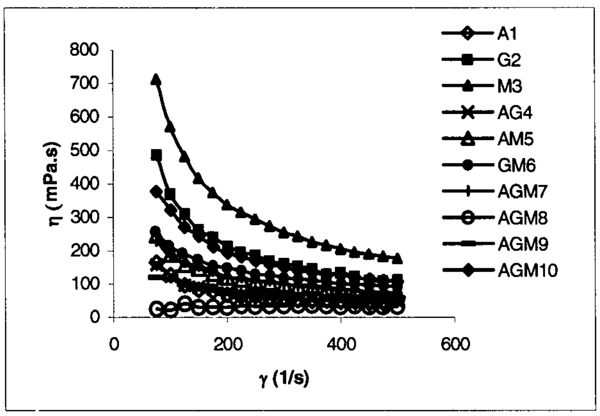

Fig 3. Apparent viscosity (η) vs shear rate (γ) at pH 6.

According to fig. 4, all the samples presented statistical variation (α =0.05) in the viscosity when the pH was changed.

For the arabic gum the maximun viscosity is reported to pH 6 [5], where a progressive increment of the viscosity is presented when the pH increased. In these case (fig. 4) the maximum viscosity was at pH 5, nevertheless these differences can be due to the preparation of the sample.

The sample M3 showed the most high viscosity to pH 5, while for the sample G2, the biggest viscosity was presented to pH 4 and 5.

In the case of the binary mixtures the AG4 sample presented lower viscosity than GM6. In the mixtures with three components the highest viscosity was for the sample AGM10, this mixture have the highest concentration of mesquite gum. The mixtures AGM7 and AGM10 showed the capability to form gels.

The influence of mesquite seed gum on the physical properties of other polysaccharides has not been studied, for that was interesting to observe the antagonistic effect between the arabic gum and mesquite gum. On the other hand, the binary dispersions with mesquite seed gum didn't present formation of gel until a concentration of 1%. This behavior could be due to the interactions between molecules of polysaccharides, since it is known that the galactomannans molecules have interactions with themselves or with other polysaccharides [3]. Actually is known that the gellan and gelatin or arabic gum show, an approximate 60 % and 40 % increase, respectively, in gel strength to 0.5 % gellan alone [5].

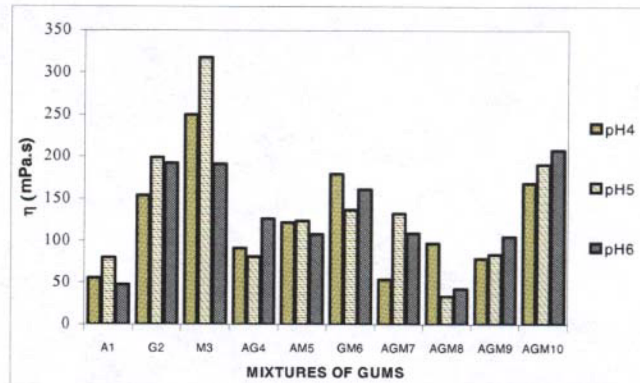

Fig 4. Apparent viscosity (η) to different values of pH.

CONCLUSIONS

Mesquite seed gum showed high viscosity, whit changes at pH values with under specific shear rate, and it showed a pseudoplastic behavior. The maximum apparent viscosity was observed at pH 5 and the viscosity decreases with the pH.

Mixtures of mesquite seed gum, gellan and arabic gum dispersions, showed low viscosity against each dispersion gums separately. The viscosity of these mixtures also changed when the pH conditions was changed. An apparent antagonistic behavior was observed for the arabic gum respect to viscosity of the mixtures at any concentration.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to P. Méndez and M. Márquez for technical assistance.

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