# Unique Properties of High Viscosity Gums

Craig A. Hoppe* and Animesh Goswami

Rhodia Food Ingredients, Cranbury, NJ 08512, USA

SUMMARY: Guar gum, a galactomannan from the seed endosperm of the legume, *Cyamopsis tetragonolobus*, is an important food stabilizer used in a variety of food products ranging from sauces to ice cream. Two guars having viscosities 13-250% higher than conventional guars were studied. Viscosity, effect of shear rate on viscosity, synergy with xanthan gum, granulation, galactomannan content, molecular weight, and scanning electron microscopy of the guar types were evaluated. At equal usage levels of guar, the high viscosity type showed a higher viscosity alone and in combination with xanthan gum under all conditions tested. The high viscosity products have electron microscopic morphology that is more elongated and molecular weights which are greater than normal guars. These factors are discussed in light of the viscosity differences which exist between these products.

## Introduction

Guar gum, a galactomannan from the seed endosperm of a legume (*Cyamopsis tetragonolobus*), is an important food stabilizer used in a variety of food applications including sauces, ice cream, baked goods, soups, gravies, and pet foods[1)]. Guar gum functions by binding or ordering water upon hydration allowing viscosity to build and water to be structured in the system[2)]. It is not surprising therefore that guar gum is used in foods for thickening, syneresis control, texturizing, and as a formulation aid. It is known that the viscosity yield of guar gum can be increased by decreasing the amount of seed hull and other non-gum entities in the final product by additional purification of the guar splits. However, there are properties which affect water binding by guar gum which are poorly understood. It is the purpose of this study to define properties which distinguish a group of higher viscosity (HV) guar gums from traditional guar products.

## Experimental

**Guar Hydration.** Guars were dispersed at 1% (dry weight) in deionized water (5-liter stainless steel beaker) at a total sample weight of 3600 gm colloidal suspension. Gum was added over 25 seconds using a mixing speed of 4500-5500 rpm (Silverson L4R-T mixer with 5 hole disintegrating head). Thereafter, mixing speed was adjusted to 9000 rpm and temperature controlled at 75°F. At various times, samples were removed for viscosity

 CCC 1022-1360/99/$ 17.50+.50/0

measurements using a Brookfield RVT viscometer (20 rpm, spindle 4). After using the samples, they were returned to the 5 liter beaker to maintain constant volume over the test period. Alternative hydrations were done under lower shear conditions using a Heidolph mixer (Brinkman Instruments) equipped with a high efficiency paddle assembly (Cole-Parmer, Vernon Hills, IL) mixing at 1000 rpm.

**Scanning Electron Microscopy.** Guar powders were mounted onto Cambridge style specimen holders with double sided carbon tape. The sample mounts were coated with 500 Angstrom of gold utilizing a Polaron Scanning Electron Microscope (SEM) gold sputter coater. The samples were analyzed at 20 kV using a JOEL 35CF SEM.

**Molecular Weight Determination.** Gel permeation chromatography (GPC) with refractive index detection alone gives almost superimposable elution profiles for the three different guars. Thus it is not possible to determine significant difference in molecular weight by simple GPC and a calibration curve with refractive index (or any other non-absolute) detection method.

The absolute molecular weights of different guar samples were determined by GPC coupled with a refractometer (RI R410, Waters Instruments) and a light scattering detector (DAWNS DSP MALLS, Wyatt Technology) using data analysis performed by Astra 2.0 software from Wyatt Technology. Chromatography was done using three Shodex columns (SB806HQ, 5$\mu$m, 30cm) and a mixture of 0.001 M sodium nitrate and 0.001 M formate buffer as eluent. Column temperature was maintained at 40°C during runs. Prior to chromatography, samples were prepared by stirring at 1g/l in eluent at room temperature for 24h followed by filtration through a 0.45$\mu$m Gelman GHP filter. To avoid errors from integration of the base-line, the similarity of Mw (weight average molecular weight) for all distributions were compared to the molecular weight calculated by Zimm Plot at peak refractive index.

## Results and Discussion

Hydration of guar gums under continuous high shear mixing showed that all but one (Uniguar 200) reached maximal viscosity at approximately 10 minutes (Figure 1). Uniguar 200 required 20 minutes. The HV guars (Jaguars 7500X and 6000) appeared to adjust to a somewhat lower viscosity after peaking at 10 minutes. Although the kinetics of hydration were similar for the HV and normal guar products, the viscosity yield is significantly different

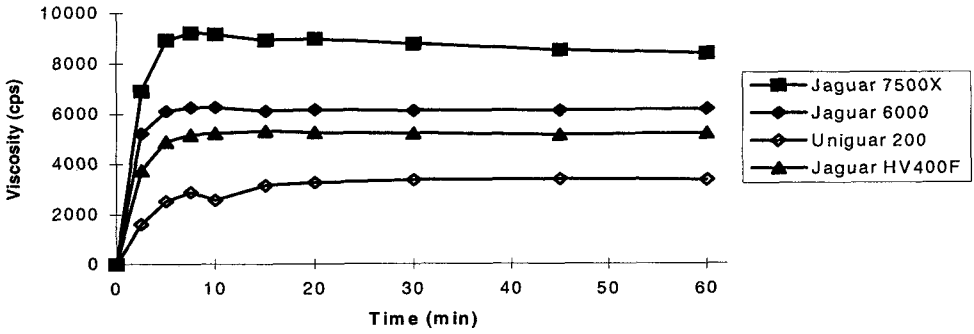


**Figure 1.** Hydration rate of high viscosity guars (Jaguar 7500X and Jaguar 6000) and normal guars (Uniguar 200 and Jaguar HV400F).

and ranged from 13% (between Jaguar 6000 and Jaguar HV400F) to 250% (between Jaguar 7500X and Uniguar 200) higher for the HV gums.

In other experiments, the effect of shear on viscosity and the guar-xanthan ratio at which maximum synergy occurred are close for both HV and conventional guars.

SEM illustrated a difference in morphology between the Jaguar guar products (Figure 2). The HV products showed more elongated projections from the granule than the conventional product (Jaguar 4500F). This gross structure may be indicative of the secondary structure of the polysaccharide chain. The elongated structure may allow more complete hydration of the polymer because of a more accessible polymer backbone.

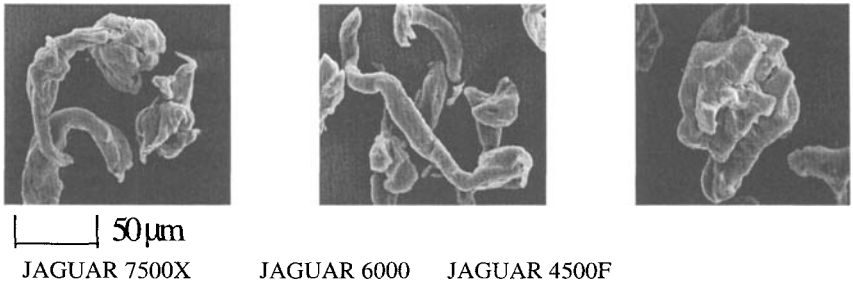


**Figure 2.** Scanning electron microscopy of high viscosity guars (Jaguar 7500X and Jaguar 6000) and a normal guar (Jaguar 4500F).

GPC coupled with light scattering indicated that the molecular weight for the HV guars (Jaguars 6000 and 7500X) are higher than Jaguar 4500F by 10 and 20%, respectively (Table 1). This molecular weight difference could itself explain the greater viscosities in the HV products.

**Table 1.** Molecular weight determination of guar gums by gel permeation chromatography coupled to refractometer and light scattering detector.

| Guar Product | Molecular Weight | | Radius of Gyra |
|---|---|---|---|
| | Zimm Plot | Wt Aver | *nm* |
| Jaguar 7500X | 2,460,000 | 2,570,000 | 158 |
| Jaguar 6000 | 2,290,000 | 2,370,000 | 154 |
| Jaguar 4500F | 2,080,000 | 2,120,000 | 145 |

## Conclusions

The performance of guar gum in a finished food product to give higher viscosity means that the product can be formulated with less guar gum perhaps resulting in less beany flavor and the placement of guar gum at a lower position on the ingredients statement. At a higher level of complexity, the HV guar gums may yield new properties due to their unique structure and higher molecular weights.

## Acknowledgments

The authors wish to acknowledge the skilled assistance of Douglas Radtke, William Carton, Amr Shaheed, and Nirali Patel. We are indebted to our colleagues at CRIT-C in Saint Fons, France for the molecular weight determinations.

## References

1) Herald, C.T. In "Food Hydrocolloids", Vol 3, ed. M. Glicksman. CRC Press Inc., Boca Raton 1986, pp. 171-184.

2) Fox, J.E. In "Thickening and Gelling Agents for Food", 2nd edition, ed. A Imeson. Blackie Academic & Professional, New York 1997, pp. 262-283.