Interfacial rheology of Acacia gums at fluid interfaces studied by interfacial shear rheometer and drop tensiometer

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Acacia gum is a naturally occurring, heterogeneous mixture of arabinogalactan-proteins, valued for its surface activity in industrial applications. We investigated the rheological properties of two Acacia gum dispersions (species *A. senegal* and *A. seyal* gum) in bulk and especially at fluid interfaces.
Using bulk rheology with a shear rheometer and two different geometries (cone-plate and concentric cylinder), the Acacia gum dispersions (5 wt%) displayed viscoelastic behaviors that intensified with time. The addition of a minor amount of a non-ionic surfactant (Tween 80) in Acacia gum dispersions eliminated the viscoelastic behavior. Hence, the observed viscoelastic behaviors at low Acacia gum concentrations and low strain can be primarily attributed to the interfacial effects of Acacia gum macromolecules adsorbed at the air-water interface, and not only to the bulk response.
Considering the previous bulk rheology results, and using interfacial rheology with an interfacial shear rheometer, both gums adsorbed onto air-water and hydrophobic phase-water interfaces and formed interfacial networks (interfacial shear moduli $G_i' > G_i''$). For the three investigated hydrophobic phases with different hydrophobicity (*n* -Hexadecane, MCT, Undecanol), *A. senegal* gum exhibited much faster interfacial network formation and higher viscoelasticity than *A. seyal* gum. Additionally, *A. senegal* gum exhibited increased adsorption kinetics and interfacial viscoelasticity with increasing hydrophobicity. Both G_i' and G_i'' increased slightly with time and never reached a plateau even after days, which is believed to result from increased lateral interactions, dehydration and/or multilayer formation at the interfaces. This point was also supported by the results of dynamic interfacial tension using drop tensiometer. However, for interfacial dilatational moduli ($E' > E''$) determined by drop tensiometer, both E' and E'' increased to a maximum and then slowly decreased with aging. No significant differences in E_{max} were observed for the two gums. The contrasting differences between the shear and dilatational properties may be due to the inappropriacy of the drop tensiometer for determining complex interfaces that cannot be described by the Young-Laplace equation. Furthermore, the presence of interfacial shear resistance further complicates the interpretation of the dilatational moduli.

Keywords:
Interfacial rheology, drop tensiometer, Acacia gum, viscoelastic, shear, dilatational properties

Acknowledgements:
The authors would like to thank the Alland and Robert Company for the financial support and Catherine Garnier and Camille Jonchère (INRAE, UR BIA) for the technical and scientific support to the interfacial rheological measurements.