Comparing different commercial fenugreek galactomannans for the production of emulsions with high intensity sonication. Effect on physical stability and rheological properties.

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Introduction

Galactomannans are considered very effective thickening agents and stabilizers for the food industry. Moreover, guar, locust bean and fenugreek gum present emulsification activity that depends on molecular weight and the mannose/galactose ratio (M/G). In addition, fenugreek gum is known to form a relatively thick layer on the oil interface and is able to produce emulsions with a much smaller droplet size in comparison to various other gums. This ability is often related to the presence of residual protein, depending the removal method enzymatic or chemical. From a dietary point of view, the viscous property has been proved to reduce in vitro the absorption of glucose and the plasma levels of triglycerides and cholesterol in vivo.

Aim

The purpose of this study was to investigate the effect of different commercial fenugreek galactomannans (FGs) on the stability of o/w model emulsions produced by ultrasonic emulsification. Overall stability, emulsification and rheological properties are compared to those of two well established for the food industry gum hydrocolloids guar (GG) and locust bean gum (LBG) to propose as a possible substitution in salad dressing products. Impact of sonication on the viscosity of gum solutions is also discussed.

Materials & Methods

High intensity sonication (20kHz, 4min, 70 and 90% amplitude) was used to prepare secondary whey protein model emulsions (pH 3.8). Primary/coarse emulsions prepared with a high shear device contained 2.7wt% whey protein isolate (WPI, 92%wt in protein, Arla Foods), 20wt% extra virgin olive oil (Elais) and four different types of commercial fenugreek gums FGA, FGB, FGH (AirGreen, Japan) and FGD (Fenulife, Frutarom, Belgium) at 0.25 and 0.5wt% concentration. FGs differ in galactomannan and protein content (Table 1) according to manufacturer.

A multiple light scattering (MLS) device (Turbiscan 2000MA) was used to collect daily back scattering (BS) profiles of emulsions during cold storage (10 days, 5^{o}C) and the creaming index (CI%) evolution was estimated. The emulsifying capacity of different gums was observed from BS profiles for a 20min.

Diffusion NMR spectrometer (Bruker Gmbh) was used for the oil droplet size measurements at 20^{o}C.

A stress-controlled rheometer with a plate-plate geometry provided viscosity profiles of 1%wt gum solutions (25^{o}C, 5-200Pa). A falling sphere viscometer was used for the dynamic viscosity of 0.5% ultrasonicated gum solutions (25^{o}C).

Table 1: Composition in galactomannan and protein of different FG gums

	Galactomannan (%)	Protein (%)
FGA	80.7	0.30
FGB	61.2	4.10
FGD	83.2	-
FGH	88.7	-

Results & Discussion

As seen in Figure 1 FGA, FGH and FGD produced solutions with much higher or equal viscosities in comparison to GG and LBG. Sonicated 1% gum solutions had significantly lower viscosities with a more newtonian behavior (data not shown). Sonication treatment had a greater impact on FG gum solution viscosity, whereas GG and LBG were less affected (Figure 2).

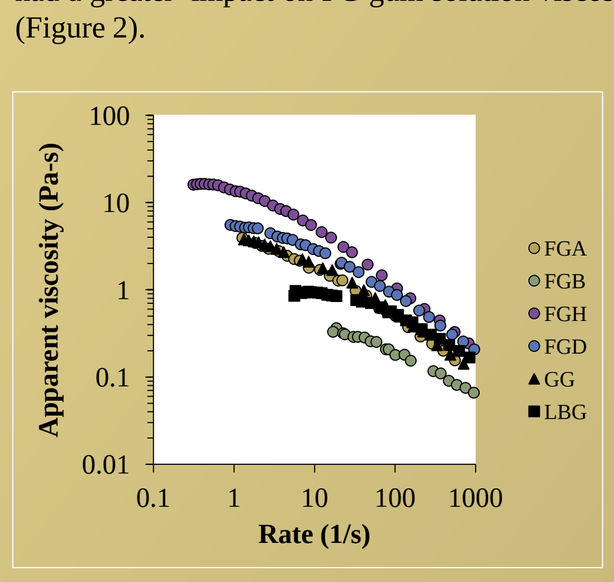

Figure 1: Apparent viscosity of 1% galactomannan solutions.

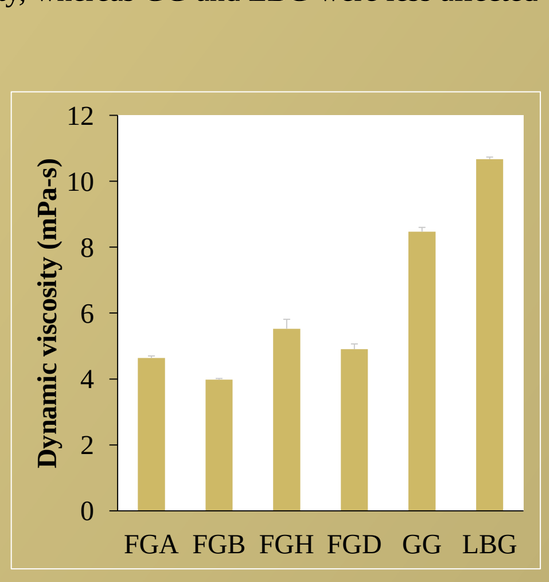

Figure 2: Dynamic viscosity of ultrasonically treated (90% amplitude-1min) of 0.5% galactomannan solutions.

Residual protein (FGB) and higher galactommanan content (FGD, FGH) at a concentration of 0.25% provided emulsions with a smaller droplet size than GG and LBG (Table 2), hence their stability against creaming was more pronounced (Figure 4). The emulsifying capacity of FGs was more pronounced (Figure 3) with the exception of FGH. GG presented limited emulsifying properties.

Table 2: Droplet size (median diameter, D_{50}) as affected by the concentration of different galactommans.

	D_{50} (μm)	
	0.25%	0.5%
FGA	2.16	1.38
FGB	1.44	1.5
FGH	1.61	1.55
FGD	1.07	1.37
GG	1.94	1.38
LBG	1.96	1.51

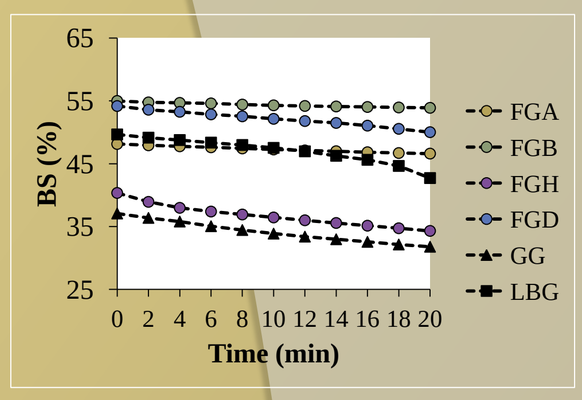

Figure 3: Back scattering kinetics of emulsions prepared with 0.5% galactomannans as an emulsifier (in the absence of WPI).

Increase of the gum content to 0.5% resulted in further droplet size reduction and emulsions of similar droplet sizes, assuming that the creaming index in this case is mainly influenced by the viscosity of the continuous phase.

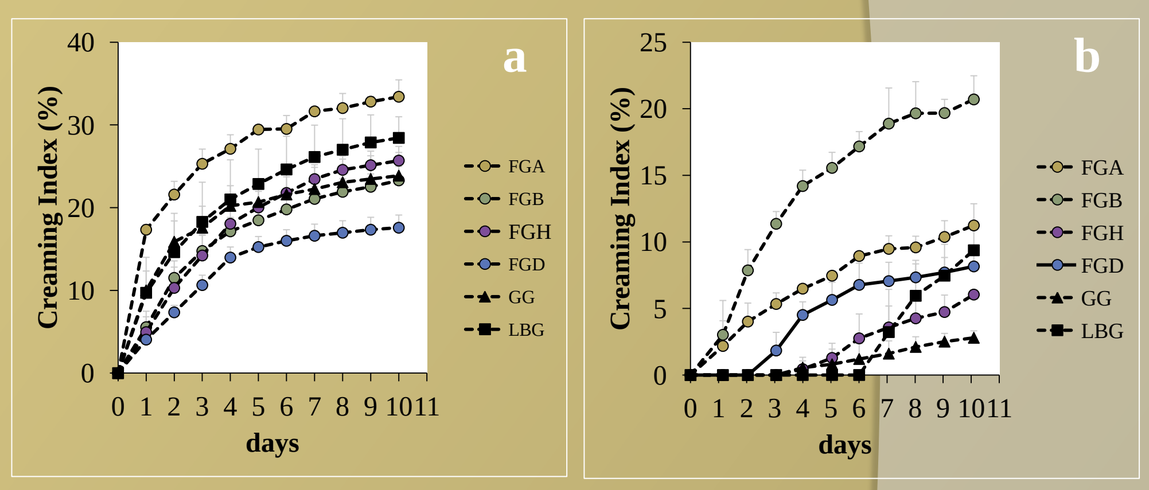

Figure 4: Stability of emulsions during cold storage (5^{o} C) containing a) 0.25% and b) 0.5% galactomannans

Conclusions

-Ultrasonic treatment decreased the viscosity of gum solutions and resulted in emulsions with small droplet sizes (<2μm).

-The size was affected by gum concentration and finer oil droplets were produced (≈1.5μm). GG and FGH at 0.5% concentration were the most stable formulations.

-Among different FGs, those containing higher amounts of galactomannan (FGD, FGH) or residual protein (FGB) formed smaller oil droplets at 0.25% concentration.

-FGs could be consider as alternative stabilizers to create healthier salad dressing products.

-Future work will include the investigation of surface and interfacial tension properties of untreated and ultrasonically treated hydrocolloid suspensions, in order to fully investigate the depolymerization effect upon the stability mechanisms.

References

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Acknowledgements

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.