Oleogel Containing Beeswax and Monoglycerides as a Potential Substitute for Confectionery Palm Fats

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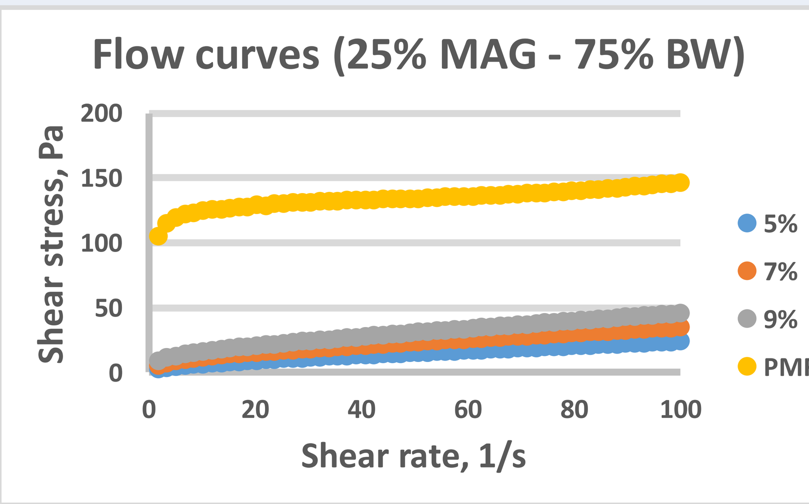
Introduction

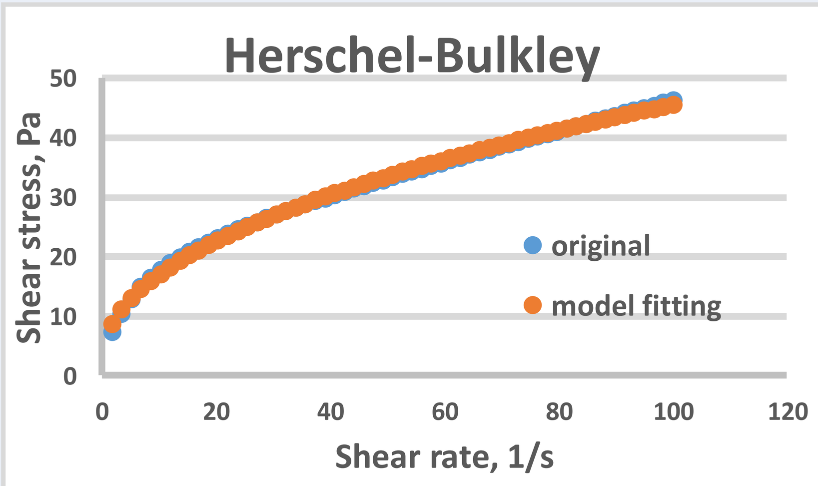
Our research was focused on the creation of a low-saturated oleogel that could serve as a viable alternative to the specialty fat „PMF – Arriba Tropic„ commonly used in chocolate fillings. Oleogelation is a process in which liquid oil with a gelator – a structuring agent - takes on a such semi-solid structure like the easily spreadable fats and this three-dimensional network structure encloses the liquid oil (Terech & Weiss, 1997; Toro-Vazquez et al., 2007; Davidovich-Pinhas, 2018). Our samples were formulated using monoglycerides (MAG), beeswax (BW), and highly unsaturated high oleic sunflower oil (HOSO). Our objective was to develop a range of mixtures with varying proportions that could be used to partially substitute the specialty fat. The concentration of the gelling agent was 5, 7 and 9 (weight) %. The beeswax:monoglyceride ratio was 1:0, 1:3, 1:1, 3:1 and 0:1.

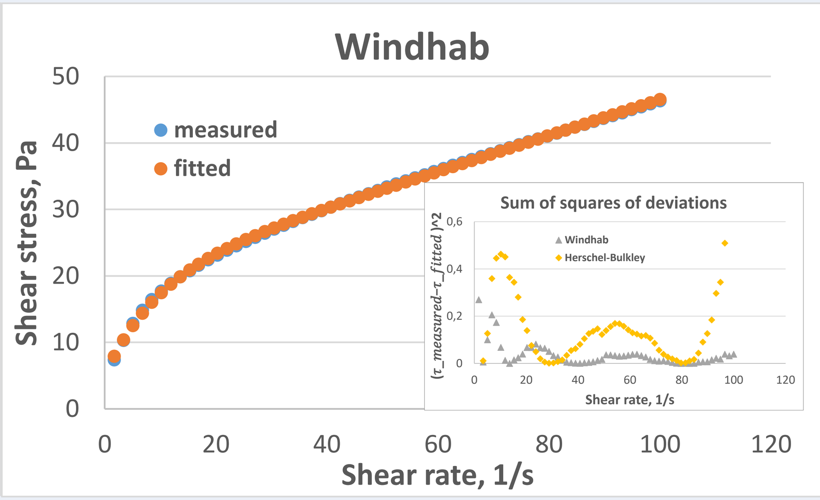
Flow curves

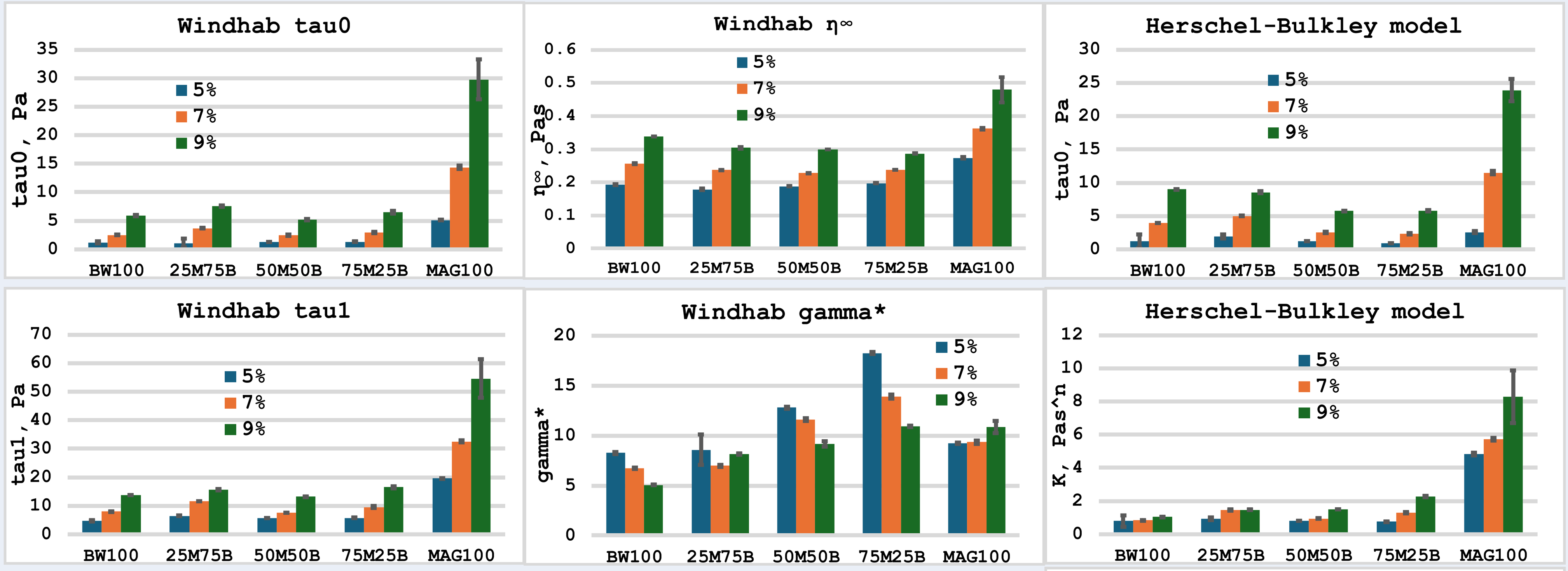


Typical flow curves

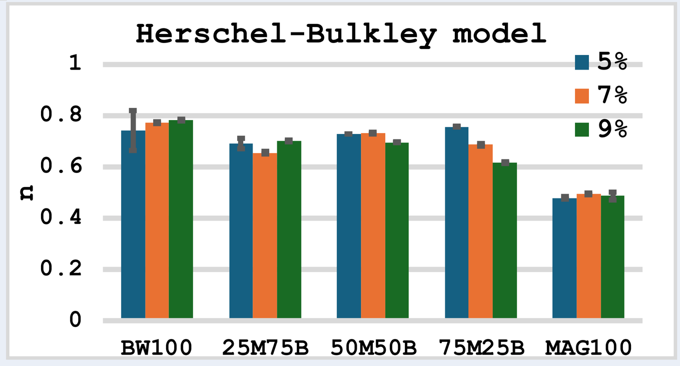
In flow curves measured with Anton-Paar MCR 302 oscillation rheometer in rotation method with cone-plate geometry up to 100 1/s shear rate the shear stress values for the oleogels were much lower than the shear stress values of the reference fat. The shear stress values increased with increasing concentrations of gelling agents. As the viscosity values decreased with increasing shear rate, the tested materials exhibited pseudoplastic behaviour. The highest yield stress (τ0) of the mixed gelators was achieved with the 3:1 BW - MAG mixture, probably due to the formation of mixture crystals.



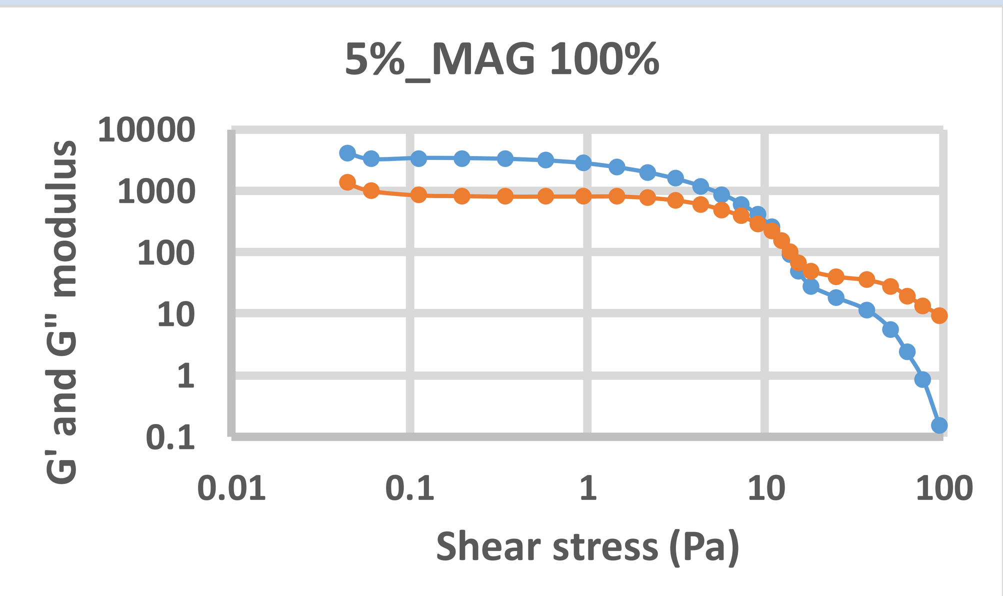




Herschel-Bulkley and Windhab models were fitted to the flow curves. At low and high shear rates, the Windhab model gave a better approximation than the Herschel-Bulkley model. The "n" flow index values were less than 1 for all the samples, i.e. the materials had pseudoplastic properties.



Amplitude sweep

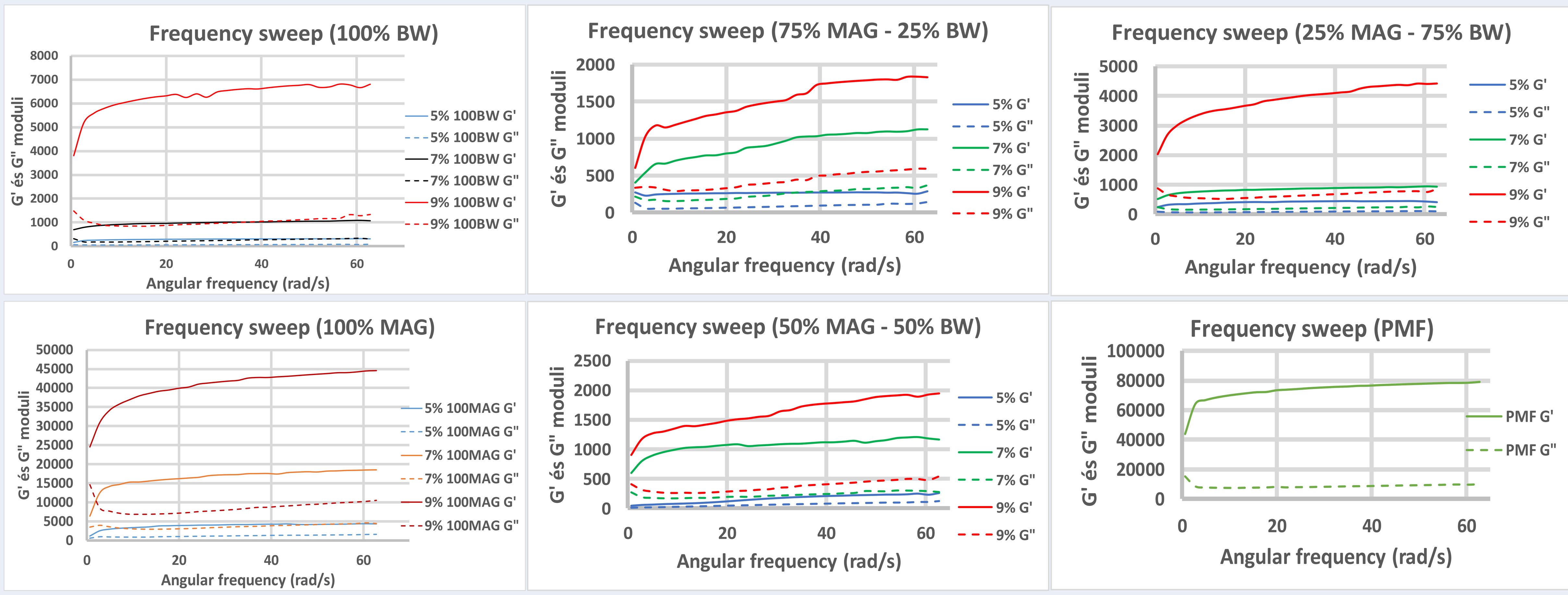


Typical amplitude sweep curve

For all samples measured with Anton-Paar oscillation rheometer in oscillation mode, G' was greater than G" at low shear, i.e. all samples showed elastic properties at low shear strain and all samples had yield points. The PMF fat had the highest G' and G", which were significantly different from the G' and G" of all oleogels. As the concentration of the gelling agent increased, so did the modulus values.

	G' = G''			G' = G''	
	Average (Pa)	SD (Pa)		Average (Pa)	SD (Pa)
5%_MAG100%	141.085	2.05768073	7% 25%_MAG - 75% BW	59.656	1.2819099
7%_MAG100%	282.655	26.3680119	7% 50%_MAG - 50% BW	51.317	1.24815183
9%_MAG100%	756.12667	33.4851166	7% 75%_MAG - 25% BW	37.5396667	2.66561294
5%_BW100%	39.636333	8.08285657	9% 25%_MAG - 75% BW	174.786667	44.845843
7%_BW100%	118.59567	45.6533044	9% 50%_MAG - 50% BW	107.12	1.09
9%_BW100%	601.75	24.7313647	9% 75%_MAG - 25% BW	130.973333	1.57557397
5% 25%_MAG - 75% BW	21.932	3.52473077	PMF	8570.66667	747.571952
5% 50%_MAG - 50% BW	20.785667	0.3595919			
5% 75%_MAG - 25% BW	28.792333	1.77455469			

Frequency sweep



Frequency sweep was performed at a shear deformation of 0.01% (in the linear viscoelastic range). The frequency sweep curves showed a slight increase in the moduli G' and G" as a function of frequency for oleogels containing one and two types of gelling agents, respectively. This may suggest that our oleogel samples can be stable over relatively long periods of time. The values of the oleogel curves were very low compared to the "Ariba tropic" fat, so it was not possible to plot all the samples in one figure.

References

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