Rheological and Mechanical Comparison between Dietary Fibers and a Novel Superabsorbent Biodegradable Hydrogel (SAEF®)

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Introduction

Obesity, which is rapidly becoming a global epidemic, has numerous deleterious sequela (e.g., cardiovascular disease), creating a significant economic burden on society [1]. Certain fibers are used for weight management because of their ability to increase the viscosity and elasticity of the contents of the GI tract, which in turn leads to slower gastric emptying and improved glycemic control [2]. SAEF® is a unique, biodegradable hydrogel, composed entirely of food components, which rapidly hydrates to occupy stomach volume and increase both viscosity and elasticity in the GI tract **(fig. 1)**. We compared the rheological properties of SAEF to three leading fibers (guar gum, glucomannan and psyllium) by measuring both viscosity (η) and elasticity (i.e., the storage modulus G'), demonstrating the superiority of SAEF to these fibers with regard to the key physical properties for inducing satiation.

Fig. 1: SAEF Mechanisms

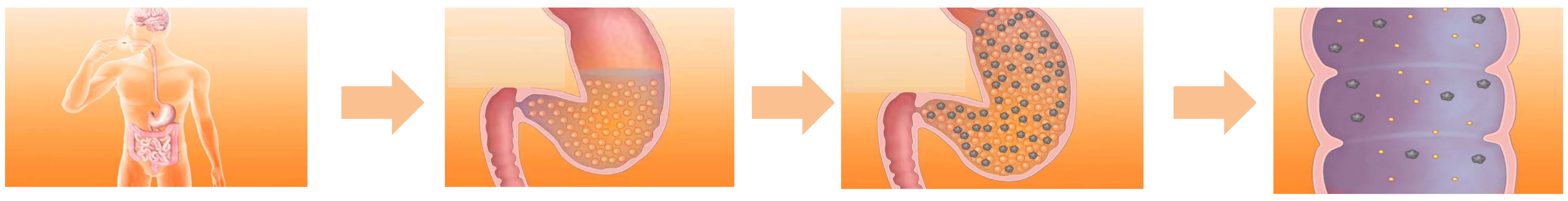
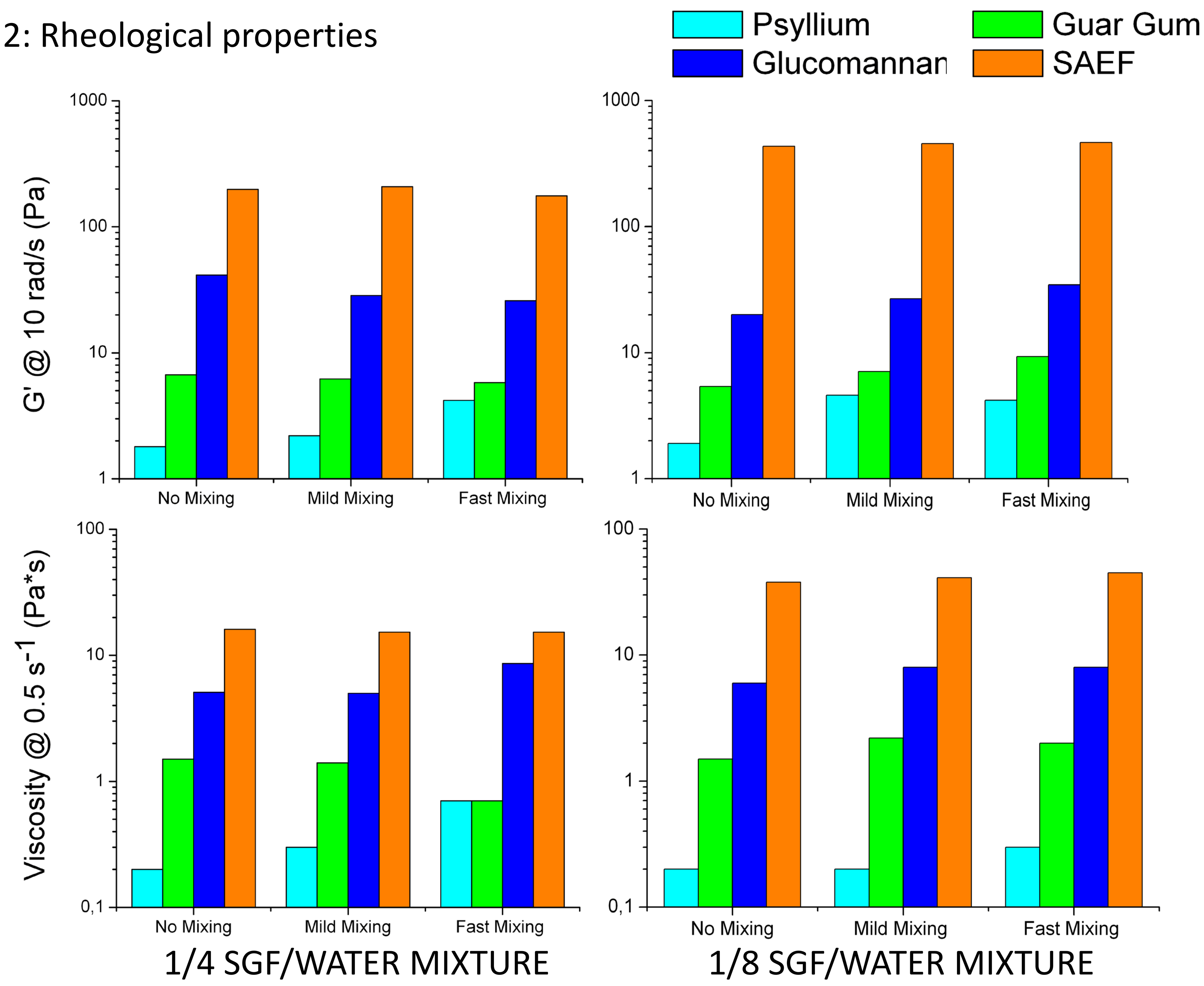


Fig. 2: Rheological properties



Experimental Methods

SAEF, guar gum, psyllium and glucomannan were placed in mixtures of simulated gastric fluid (SGF)[3] with water in a ratio of 1/4 or 1/8 for 30 minutes at room temperature. The samples were subjected to no mixing, slow mixing (60 rpm), or fast mixing (600 rpm) and then rheological measurements were taken. Averages were taken of samples prepared and measured in triplicate. Samples were poured into the cup of a rotational rheometer (ARES Rheometer, TA Instruments) equipped with plate and cup (3mm high) tools (ϕ=50mm) which was used for rheological testing. Viscosity tests utilized a rate range of 0.05 s^{-1} to 10 s^{-1} and values were recorded at 0.5 s^{-1}. For the frequency sweep test, the rheometer was set such that the strain was 0.5% (measured from a preliminary strain sweep test performed at fixed frequency of 6.28 rad/sec), with a frequency range between 0.5 rad/sec and 100 rad/sec and recordings were noted at 10 rad/sec.

Results and Discussion

This study demonstrates that SAEF has greater viscosity (η) and elasticity (G') than guar gum, glucomannan and psyllium at both SGF concentrations tested and at different mixing rates **(Fig. 2)**. It was also observed that SAEF was faster to reach peak viscosity and elasticity levels than comparator fibers. The differences in performance, which were shown consistently throughout the testing process, likely stem from structural differences between SAEF and comparator fibers. While SAEF's cross-linked structure creates rapidly hydrating individual particles with consistently high elasticity and viscosity, comparator fibers act in part by creating physical entanglements [4], which may result in less favorable performance.

Conclusions

SAEF, a unique hydrogel composed entirely of food components, clearly outperformed three leading fibers with regard to viscosity and elasticity in a simulated gastric environment. Given that viscosity and elasticity are key properties for inducing satiation, our results suggest that SAEF should be more effective than the tested fibers in causing satiation.

References

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