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Extended Abstract

Investigation the Rheological Properties of Nanofiber Gel Prepared from Tomato Pomace as a Function of Concentration

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Abstract

In the current study, the nanofiber gel of tomato pomace was prepared using a super disk grinder device available at Nano Novin Polymer Co., Iran. Three different concentrations (2, 4 and 6%) of the gel prepared and rheological tests including amplitude sweep, frequency sweep, temperature sweep, and flow behavior were done. DLS results showed that the average diameter of tomato nano-gel was around 38 nm. The power law model was chosen as the best model for describing flow behavior data. All samples showed a shear-thinning behavior that viscosity decreased with increasing shear rate. A hysteresis loop was observed in all samples which confirmed the thixotropic characteristic of gels. Based on amplitude sweep data, elastic modulus (G') was higher than viscous modulus (G"), in addition, crossover points of all gels showed that the flowability decreased with increasing concentrations. Based on frequency data, G' in all concentrations was higher than G" and both parameters increased with increasing concentration from 2 to 6%. In lower frequencies, all gels showed solid-like behavior while G' and G" increased with increasing frequency indicating the weakening of the gel network. G' and G" gradually decreased with increasing temperature from 5 to 50 ºC which confirmed that all gels were weakened at high temperatures, but in the cooling cycle, all gels recovered their structures and no remarkable hysteresis was observed.

Keywords: Amplitude sweep, Frequency sweep, Rheology, Temperature sweep, Tomato nanofiber gel

Introduction

Tomato (*Lycopersicon esculentum*) is one of the most important crops in the world mainly used to produce products like tomato juice, paste, puree, ketchup and sauce, and etc. (Schieber, Stintzing, & Carle, 2001). However, tomato waste or pomace can be used as a low-caste source of vitamins, carotenoids, essential oils, fibers and so on, hence in recent years aforementioned wastes has gained a lot of attention among researchers to recover those bioactive compounds (Grassino *et al*., 2016). Rheological properties of food products in food industry is highly important since they represent that to what extent the product can tolerate the processing conditions. Hence, in this study focuses on the rheological and dynamic properties of the tomato pomace nano fiber gel.

Materials and methods

Oven-deride tomato pomace was mechanically refined by Super mass collider grinder to obtain a gel with 6% concentration. Gels at 2 and 4% concentrations were prepared by adding a given amount of water to the gel followed by ultra-sonication. Particle size diameter was measured by dynamic light scattering (DLS) method.

Rheological properties of TPNFG were measured using a controlled stress/strain rheometer (Anton Paar, MCR 301, Austria) equipped with a double gap geometry (0.02 mm gap). Flow behavior of samples was determined with increase in shear rate from 0.01 to 300 s^{-1} and Power-law model was used to fit the experimental flow curves. Where n: power law index, K: consistency ($Pa.s^n$),τ: shear stress (Pa), D: shear rate (s^{-1}).

$$\tau = K\gamma D^n \qquad (1)$$

Strain sweep test was carried out over a strain range of 0.01 to 100% at constant frequency of 1 Hz. Frequency sweep were done over a range of 0.01-100 Hz at constant strain (0.1%). Temperature sweep were performed at a fixed strain of 0.3 with a frequency of 1 Hz, the temperature increased from 5-50 °C at the rate of 5 $°C/min^{-1}$ followed by cooling step at the same condition (Razi, Motamedzadegan, Shahidi, & Rashidinejad, 2018).

Results and discussion

Mean diameter of gel particles was calculated to be in the range of 24 to 100 nm and $d_{50}$and $d_{90}$of gel were 38.5 and 85 nm respectively.

In all samples, with increasing shear rate from 0.04 s^{-1} to 300 s^{-1}, apparent viscosity decreased. It could be as a result of ordering structural molecules especially pectin by shear rate in tomato nano fiber gels which was in accordance with those reported by Do nascimento et al. (2016) who claimed that in polysaccharide systems, pectin plays an important role in pseudoplastic behavior and power-law model was the best model to describe the shear thinning behavior of gels. Hysteresis area increased from 175.9 to 12042.46 for 2 and 6% gels represented thixotropic behavior of gels. All samples had higher G' than G" confirmed viscoelasticity of gels, additionally with increasing gel concentration, G' & G" values increased. in all frequency range, G' was higher than G" which in accordance with amplitude test results. G' & G" decreased with increasing temperature from 5 to 50 °C meant that gel structure weakened by rising temperature while their structures recovered during cooling.

Conclusion

In present study, gel particles size was between 24 to 100 nm. TPNFG showed a pseudoplastic flow behavior and followed power-law model. All gels had a solid-like behavior with G' higher than G". Gels structures were destroyed in high frequencies and weakened with an increasing in temperature.

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