Rheological effects of soy protein addition to tomato juice

Stefano Tiziani, and Yael Vodovotz

ABSTRACT

e potential health benefits of soy and tomatoes, attributed in part to the presence yones and carotenoids, have been associated with reduced risks of cancers and seases. A tomato juice, from concentrate, containing 1% soy protein has been ed as a delivery system for these phytonutrients. The rheological properties of this re compared to standard tomato juice using a controlled rate RFS II Rheometrics with Couette geometry at 25°C. Shear thinning behavior was observed by steady 02-200 s^{-1}) for both tomato juices with and without soy. Addition of soy, ntly affected the time dependence (studied from 10-1500 s^{-1}) of the juice. In the plain tomato juice, a slight thixotropic behavior was observed. The tomato juice ed soy exhibited a thixotropic behavior at low shear rate; at higher shear rates, a n to rheopectic behavior was observed. Steady and dynamic tests indicate a hysical gel behavior for both the samples. In the range studied (0.1-15 rad s^{-1}), age modulus was consistently higher than loss modulus. The addition of soy urther increased the modulus values enhancing aggregation between pectin and ein and stability of the suspension, without influencing the gel like-behavior. It was ed from this study, that the addition of 1% soy protein to tomato juice increases rent viscosity improving the overall rheological behavior.

INTRODUCTION

natoes and soy are two foods that possess biologically active components that nificantly impact upon health. The impact of combining these foods, developing ducts, and characterizing their functional characteristics and health benefits has investigated. The combination of soy and tomato products is particularly relevant ach component is associated with a lower risk of cardiovascular disease and cancer (1). One of the most important quality parameter of tomato products is its ; it is strongly dependent on pectins and their degree of esterification which affect al properties forming an entanglement where other particles are physically d (2). The rheological properties of tomato products (juice, puree and paste) are affected by the thermal treatment during hot or cold break. Tomato juice, like nato products, is typically shear thinning (3, 4).

protein isolates are globular which, when suspended in water, constitute a suspension. An increased consistency and a reduced serum separation have ted in tomato sauce after the addition of soy proteins, due to an increased water capacity (5). Since the physico-chemical interactions of tomato juice and soy are unknown, the aim of this research is to analyze the rheological changes of uice due to the addition of soy protein.

MATERIALS & METHODS

break tomato juice with salt added was analyzed. Tomato juice with soy was by addition of 1% soy protein isolate PTI FXPH0159 to tomato concentrate and he homogenized product was retorted around 100°C for 10 minutes. The pH was l 4.19 and the density was 1.025 and 1.027g cm^{-3} for the products without and respectively.

ady and dynamic rheological experiments were conducted at ambient ure (25°C) using a controlled rate RFS II Rheometrics system. Couette geometry d (diameter of cup 34mm; diameter of bob 32mm; length of bob 33.3mm).

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RESULTS & DISCUSSION

Tomato juice behaves as a **non-Newtonian fluid**, due to the presence of soluble pectins which, enhanced by the addition of calcium salt, creating a calcium pectate gel by binding free carboxyl groups on adjacent pectin polymers (6, 7). Steady shear experiments, reported in Fig.1 and 2 for tomato with and without soy establish the **pseudoplasticity** of both products. However the tomato juice containing soy resulted in a higher viscosity. We hypothesize that the addition of soy protein reinforces the three-dimensional network by hydrogen and hydrophobic bonding interactions.

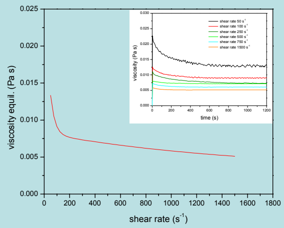

Fig. 1 Equilibrium viscosity and step rate tests for tomato juice

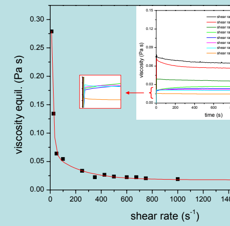

Fig. 2 Equilibrium viscosity and step r for tomato juice with soy

The addition of soy protein plays also an interesting role on the **time-dependent** behavior of tomato juice. The tomato juice a slight **thixotropic** behavior (Fig. 3, 4, 5) attributed to the breakdown of secondary bonds related to pectic links (6, 7). On t hand, the addition of soy affects the time dependence of the product in three different ways. **1.** Flow curves at maximum shear ra of <500s^{-1} show hysteresis loops due to incomplete structure recovery, demonstrating thixotropy (an example is reported in Fig. higher maximum shear rate values, the behavior is **rheopectic** (an example is reported in Fig. 4) suggesting possible aggreg gelation. **3.** At shear rate higher than 1000s^{-1}, results depict a process of aggregation followed, after the intersection in the hy loops, by a breakdown of secondary bonds (an example is reported in Fig. 5).

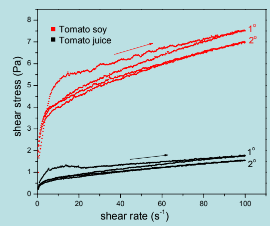

Fig. 3 Time-dependence comparison at maximum shear value 100s^{-1}

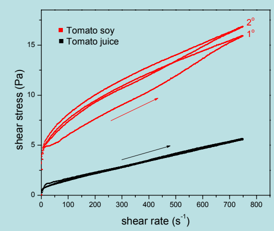

Fig. 4 Time-dependence comparison at maximum shear value 750s^{-1}

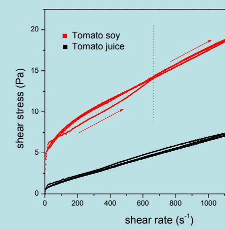

Fig. 5 Time-dependence comparison maximum shear value 1250s^{-1}

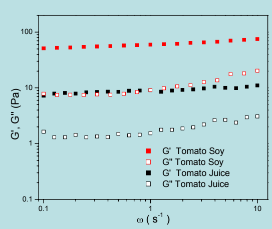

Fig. 6 Soy effect on storage (G') and loss modulus (G'')

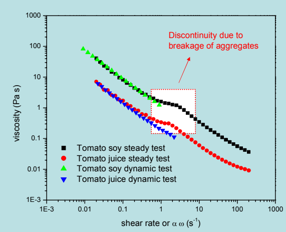

Fig. 7 Cox-Merz rule for tomato products

Both products show **gel-like** and a higher value of storage mod compared to loss modulus (Fig. addition of soy protein to tomato juice an increased difference in both modu one log as compared to tomato jui (Fig. 6).

Viscosities obtained from dyna steady tests, Fig. 7, follow a modif **and Merz rule** using α horizontal sh (8). The deviations of tomato juice without soy from the Cox and M reflect the gel-like nature of the prod confirm the important role of the se interactions on the stability of the system.

CONCLUSIONS

The tomato juice products with and without soy protein isolate depict character of "physical gels" governed by secondary interactions which are dynamically fo and broken.

The addition of 1% soy protein isolate to tomato juice:

- ✓ **increases the value of viscosity and viscoelastic moduli of tomato juice,**
- ✓ **affects the time-dependent behavior due to conformational changes o protein at different ranges of shear rate,**
- ✓ **improves the overall rheological behavior due to improved stability o suspension.**