The Effect of Cellulose on the Rheological and Thermal Properties of Collagen Paste used for Sausage Casings

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1. Introduction

It is estimated that about 80% of the edible casings used for sausage manufacturing are manufactured from collagen obtained from the corium layer of bovine hide (Harper *et al.,* 2012) and collagen casings manufacturers are looking for ways to develop collagen casings with new and desirable properties. One potential approach is to add to blend the collagen paste with polysaccharides such as cellulose to improve its properties. Cellulose is the most abundant natural biopolymer, responsible for the structural component of plant cell wall. Hence, the aim of this study is to investigate the effect of different aspect ratios (Average fibre length to width) of cellulose suspension on the rheological and thermal properties of collagen paste.

2. Materials and Methods

Cellulose powders with different fibre length; Solka floc 300 - 22 µm and Solka floc 900 -110 µm (International fibre Corporation ,New York, USA). Collagen paste was supplied by Devro plc, (Moddiesburn,Scotland).

Cellulose suspension preparation

Cellulose suspensions were prepared by dispersing a known mass of Solka floc 300 (SF3) and Solka floc 900 (SF9) in distilled water at room temperature. The collagen paste and cellulose suspensions were mixed together at mixing ratio 80:20.

Oscillation Rheology Measurements

All rheological measurements were performed on a controlled strain MCR 301 rheometer equipped with a parallel-plate geometry (50 mm plate and 1 mm gap).

Dynamic frequency sweep tests were performed from 0.1 to 100 rad/s at constant temp of 20 °C. Dynamic temperature sweep tests were conducted at a frequency of 10 rad/s and were heated from 3 °C to 80 °C at a rate of 5 °C/min

Thermal Analysis

The thermal transition of the collagen : cellulose paste was determined by micro differential scanning calorimetry (Seteram). Samples were heated twice to check if the endothermic peaks observed during the first heating were reversible or irreversible

Light Microscope

An optical microscope (EVOS f1, AMG, Washington, USA) was used for the light microscope image of the collagen with cellulose paste

3. Viscoelastic Properties

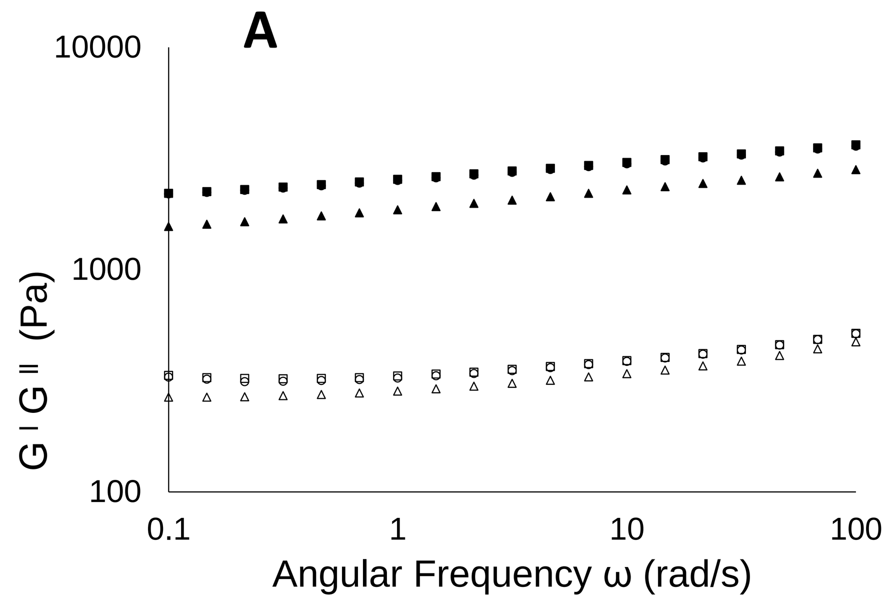

Fig 1. Elastic modulus (closed symbol) and Loss modulus (closed symbol) of collagen : Solka floc 300 (○), collagen : Solka floc 900 (□) and 4% collagen (Δ)

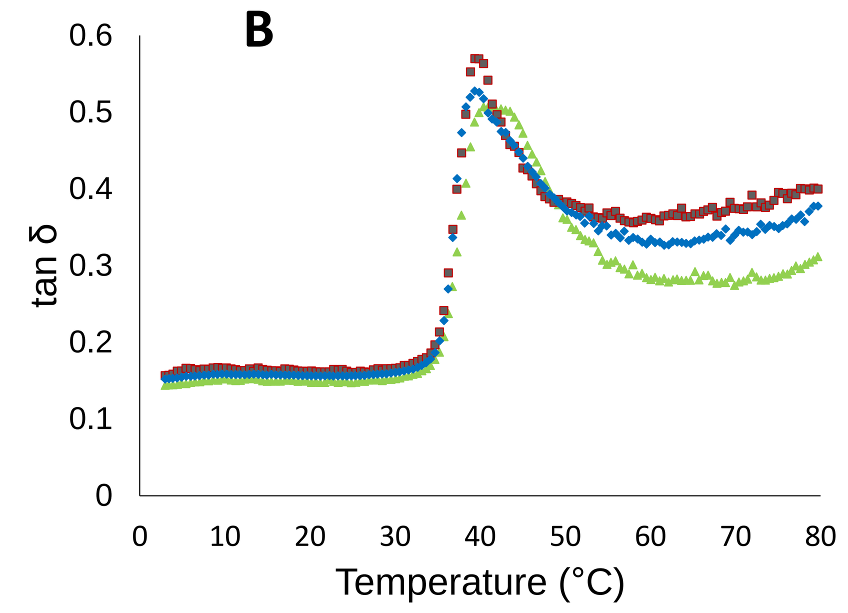

Fig 2. tanδ of collagen : Solka floc 300 (Δ), collagen : Solka floc 900 (□) and 4% collagen (◊)

- The addition of Solka floc 300 and Solka floc 900 reinforced the collagen paste by increasing the elasticity.
- Similar effect were observed for both celluloses when added to the collagen at fixed phase volume.
- In dynamic temperature sweep tests, the peak value of tan δ was chosen as the denaturation temperature (Fig 3B). The maximum peak value of tan δ was similar within the samples ranging from 39.4 °C to 40.4 °C

4. Thermal Transition

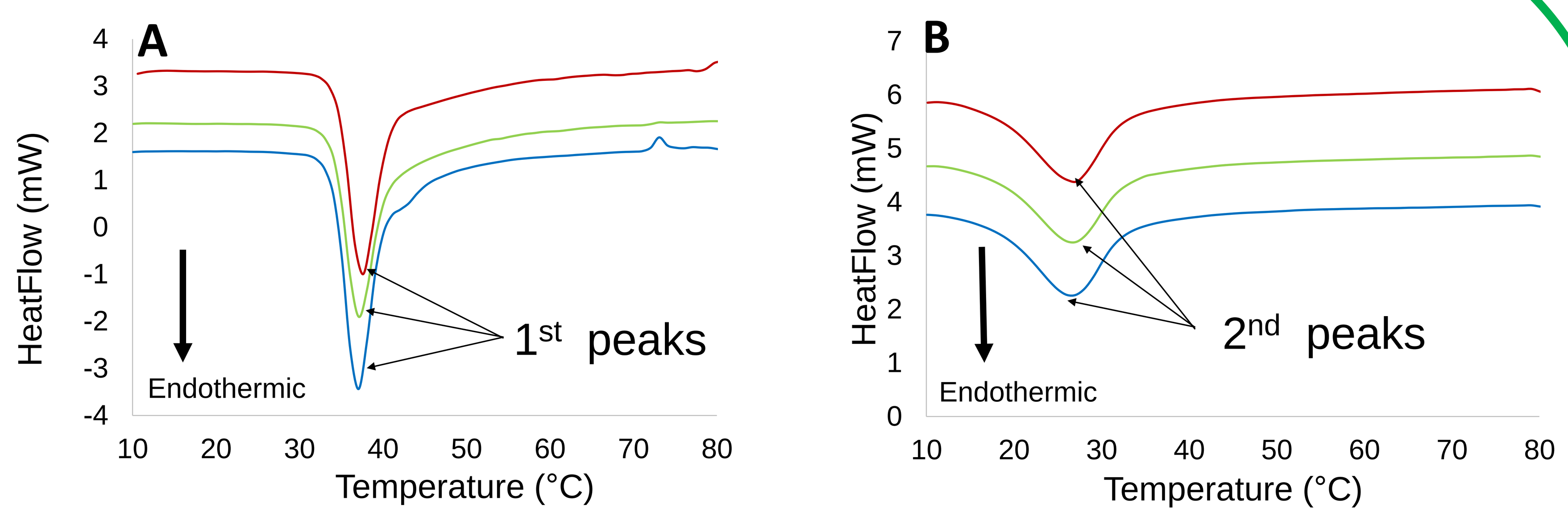

Fig. 3. DSC thermograms of (A) 1st heating (B) 2nd heating of collagen with Solka floc 300 paste (—) collagen with Solka floc 900 paste (—) and 4% Collagen(—) at 1°C/min

Table 1. Thermal properties of collagen paste mixed with Solka floc 300 and Solka floc 900 measured by 1°C/min between 3 to 80 °C

	4% Collagen		Collagen & Solka floc 300		Collagen & Solka floc 900	
	1st Peak	*2nd Peak*	*1st Peak*	*2nd Peak*	*1st Peak*	*2nd Peak*
Onset Temp [°C]	34.00	17.67	33.99	17.47	33.92	17.55
Peak Temp [°C]	37.00	26.66	37.06	26.67	36.97	27.01
Endset Temp [°C]	40.63	33.29	41.12	33.44	40.68	33.35
Enthalpy [J/g]	2.33	1.33	2.27	1.43	2.03	1.33

- Maximum peak temperature of the first heating run was taken as the denaturation temperature of collagen (Fig.3A)
- All the samples had similar denaturation temperatures which indicates that cellulose did not affect collagen melting temperature.
- The 2nd peak has a lower denaturation temperature (Fig.3B).
- Heating of collagen leads to the transformation of the collagen native triple helix structure to random coils.

5. Microstructure

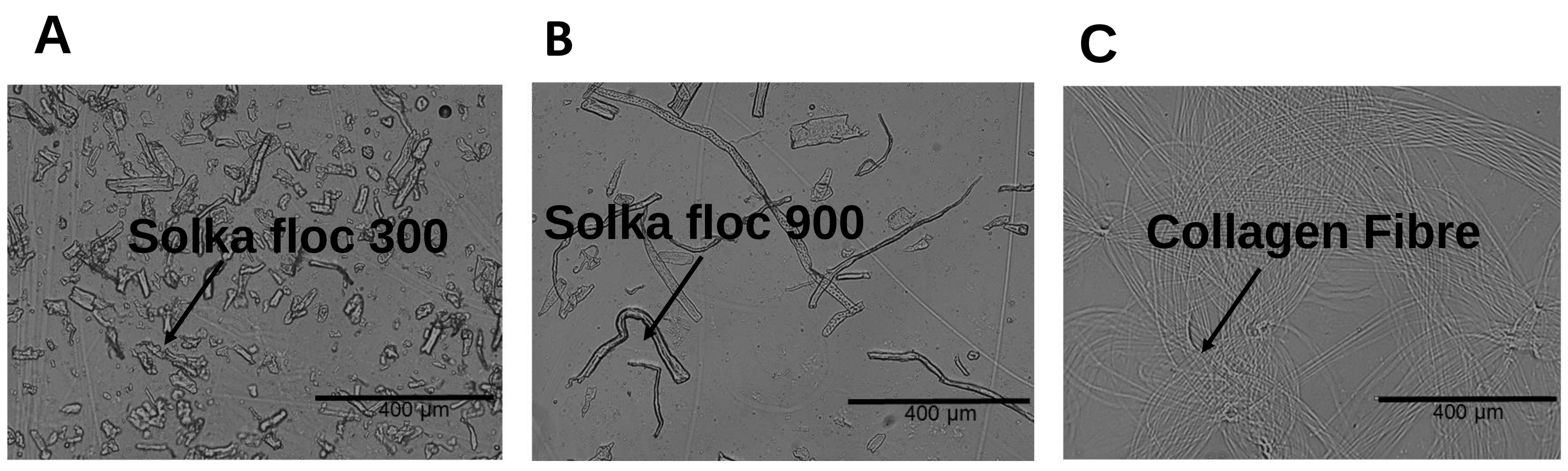

Fig. 4. Phase contrast light microscope images of (A) Collagen: Solka floc: 300 (B) Collagen : Solka floc 900 and (C) Collagen

- The collagen is fibrous in nature
- Solka floc 300 has a lower aspect ratio compared to Solka floc 900.
- Solka floc 300 has more packing efficiency because the fibers tend to fill space more.

6. Conclusion and Future work

Results of this study suggest that addition of cellulose fibers with different aspect ratios increased the elastic modulus of the collagen paste. However results from the DSC thermograms showed that the addition of cellulose fibers did not affect the melting temperature of the collagen.

Future work aims to understand the effect of cellulose aspect ratios on the mechanical and thermal properties of collagen films. Furthermore the effect of different polysaccharides charge and molecular weight will be investigated.

References

HARPER, B., BARBUT, S., LIM, L.-T. & MARCONE, M. 2012. Microstructural and textural investigation of various manufactured collagen sausage casings. *Food research international,* 49**,** 494-500.

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