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# Gelling properties of protein fractions and protein isolate extracted from Australian canola meal

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ABSTRACT

Gelling properties of canola albumin and globulin fractions, and canola protein isolate (CPI) were examined in this study. The effects of pH and salt concentration on canola protein gelling properties were studied primarily by means of dynamic oscillatory rheology and gel texture analysis. The findings were supported by confocal laser scanning microscopy (CLSM) images of the gels, isoelectric point, and solubility measurement data. All canola proteins showed typical heat-set gel protein profiles. Gels formed at higher pH had better gelling properties including higher overall resistance to deformation ($G^*$), higher gel elasticity (low tan $\delta$), higher fracture stress and firmness, and denser gel microstructure. Isoelectric points of canola proteins used in this study were in the range of pH 3.0–4.7 where low protein solubility was observed. The albumin fraction was able to form a very weak gel at pH 4, whereas the globulin fraction and CPI precipitated due to loss of protein surface charge. The effects of NaCl on gelling were protein sample dependent. The presence of NaCl negatively affected gelling properties of albumin and globulin fractions, with decreases in overall resistance to deformation ($G^*$), and fracture stress and firmness, but positively affected CPI gels in the same aspects. The elasticity (tan $\delta$) of all canola protein gels remained constant in the presence of NaCl. Frequency sweep analysis revealed that the albumin fraction and CPI formed weak gels, whereas the globulin fraction formed a strong gel. Strain sweep analysis further confirmed that the globulin fraction formed a stronger gel with a critical strain of at least 10%. This study demonstrates the high potential of canola proteins, particularly the globulin fraction, as a prospective gelling agent.



## Introduction

The ability to form gels is a key functional property of plant proteins (Schwenke, Dahme, & Wolter, 1998). Gel formation imparts desirable textural and sensory attributes to foods (McClements, 1999). Factors influencing the formation of gels are protein molecular weight, pH, ionic strength, reducing agents, temperature, the presence of non-protein components and the mechanical forces applied to the system (Damodaran, 1988; Sathe, 2002). Canola proteins have been considered as potential food ingredients where a gel-like texture is desired (Aider & Barbana, 2011; Tan, Mailer, Blanchard, & Agboola, 2011a). However, raw canola meal may contain undesirable levels of glucosinolates or their toxic breakdown products and there may be concern over the levels of these compounds in protein extracts. Our previous work has confirmed that most of the canola protein fractions obtained by the Osborne extraction method had low or no glucosinolates (Tan, Mailer, Blanchard, & Agboola, 2011b). This suggests that extracted canola proteins could be a safe ingredient for food manufacturing.

In terms of gelling properties, mixed results have been reported on canola proteins, depending on the methods and types of protein fractions prepared, as well as the method of analysis. Gill and Tung (1978) reported gelation of 12S glycoprotein fraction of rapeseed at protein concentrations as low as 4.5%, with measurable thickening at 1% protein. Research carried out by Sosulski, Humbert, Bui, and Jones (1976) and Thompson, Liu, and Jones (1982), however, reported poor gelation properties of rapeseed protein concentrate. Previous research on gelation properties has mainly focused on protein isolates (Pinterits & Arntfield, 2007, 2008) and 12S globulins (Gruener & Ismond, 1997;

*Abbreviations:* CLSM, confocal laser scanning microscopy; CPI, canola protein isolate; $G^*$, complex modulus; $G'$, storage modulus; $G''$, loss modulus; IEP, isoelectric point; NaCl, sodium chloride; NaOH, sodium hydroxide.

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Léger & Arntfield, 1993). The globulins used were prepared by the protein micellar mass technique. A previous review has documented that globulin fractions can also be prepared by the Osborne method (Tan et al., 2011a). This raises the possibility that Osborne globulin extracts could gel well compared to other reported canola proteins. The water-soluble fraction (albumin fraction) from the sequential Osborne procedure is also a fraction of interest due to the mild conditions involved during the extraction, which could retain the original protein structure. To the best of our knowledge, no study of gelling properties has been carried out on these two Osborne fractions.

In this study, the gelling properties of albumin and globulin fractions obtained using the Osborne method, and canola protein isolate (CPI) prepared using common direct alkaline method (Tan et al., 2011b), were compared at pH 4, 7, and 9, and at NaCl concentrations of 0.2 and 0.4 M at pH 7. Dynamic oscillatory rheology and texture analysis of protein gels were conducted to obtain information on the nature of the canola protein gels formed at various pH and NaCl concentrations. The protein gel networks were observed using Confocal Laser Scanning Microscopy (CLSM). Protein solubility and isoelectric points were also determined to study their effects on canola protein gelling properties.

## Materials and methods

### *Source of materials and chemicals*

Industrial cold-pressed canola meal (a mixture of different *Brassica* varieties) was generously supplied by Cootamundra Oilseeds Pty Ltd (Cootamundra, NSW, Australia). Reagents and chemicals were purchased from Sigma-Aldrich (Castle Hill, NSW, Australia).

### *Protein extraction*

Albumin and globulin fractions were prepared using the Osborne method (Sosulski & Bakal, 1969) with modifications as described by Tan et al. (2011b). Canola protein isolate (CPI) was prepared using the direct alkaline extraction method as also described by Tan et al. (2011b).

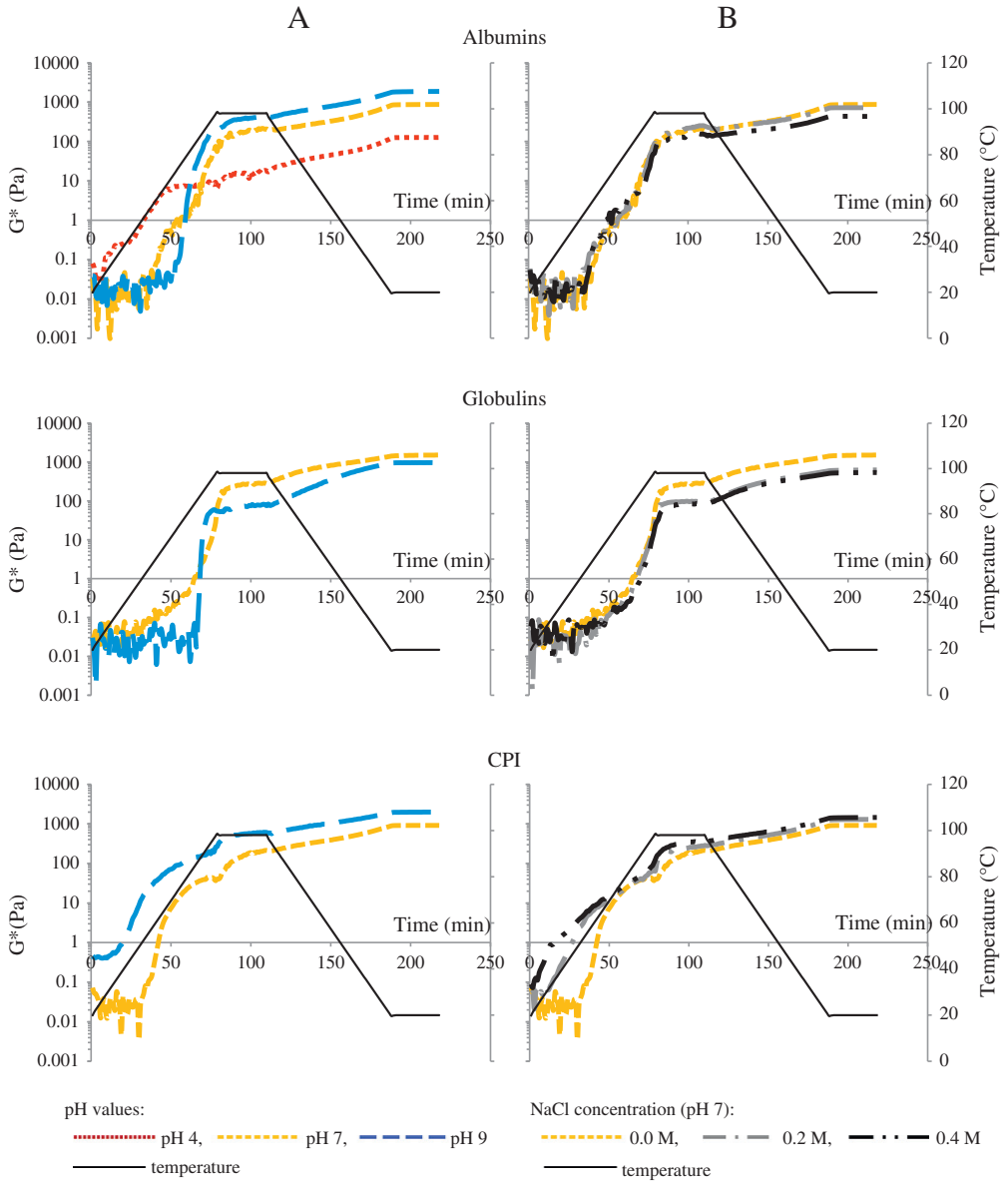


**Fig. 1.** Temperature sweep: representative curves of $G^*$ against time and temperature for various canola proteins at different (A) pH values, and (B) NaCl concentrations at pH 7 (Globulin fraction and CPI samples did not gel at pH 4).