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shown that the interfacial properties of CPI–hydrocolloid complexes were improved by electrostatic complex formation and thermodynamic incompatibility, making these systems suitable for stabilizing food emulsions, such as salad dressings and mayonnaise (Evrakpa & Arntfield, 2005).

Foaming properties

In many food applications, because the surface area in the liquid/air interface increases, proteins denature and aggregate during whipping. Air entrapment plays a major role in different food matrices and is important for flours used in many leavening food products, such as breads, cakes and cookies (Sreerama, Sasikala, & Pratape, 2008). The foaming capacity of canola meal was studied and compared with soy and flaxseed (Khattab & Arntfield, 2009). They showed that the foam capacities and stabilities of raw and treated canola meal were higher than those of soy and flaxseed meals. They expressed the foaming capacity as a percentage and reported values of 36.44%, 44.56% and 17.82%, for canola, soy and flaxseed meal, respectively. It was shown that heat treatment significantly reduced both the foaming capacity and foam stability of the different meals, including canola meal. The authors explained that this reduction was mainly related to protein denaturation; this conclusion agrees with the data reported by Lin, Humbert, & Sosulski, 1974, who stated that a native protein gives a higher foam stability than a denatured one. Graemer and Ismond (1997) conducted a study in which the canola 12 s globulin was isolated by the protein PMM and modified by acetylation and succinylation to improve the functional properties of the canola protein concentrate. The PMM foaming capacity was significantly increased by acylation, and the foam stability decreased significantly after acylation. They concluded that in general the acylated concentrates possessed improved functionality as compared to the PMM, which makes them more suitable as a food ingredient. Xu and Diosady (2002) studied the functional properties of Chinese rapeseed meals and reported that Chinese rapeseed meals foams were more stable than those of the canola meals prepared by Nacik et al. (1985). Moreover, they showed that Chinese rapeseed protein isolates were characterized by excellent whippability. They found that the foaming properties of the soybean isolate were between those of the rapeseed meals and rapeseed protein isolates. The difference between a meal and an isolate is the protein content, which is obviously higher in an isolate. All foams were stable and lasted for more than 2 h. The foaming properties of canola protein were evaluated as a function of degree of protein hydrolysis. Limited canola protein hydrolysates ranging from 3.1% to 7.7% hydrolysis were produced from an isoelectrically precipitated protein isolate. It has been shown that all canola protein hydrolysates have lower foam stabilities than those reported in the literature for other rapeseed protein products (Frokjaer, 1994), and the foam stability decreased as the degree of hydrolysis (DH) increased. The authors concluded that hydrolysates with an increased degree of hydrolysis are apparently capable of foaming but lack the strength to maintain the foam as a result of the reduction in protein molecular weight. The foam stability of the protein isolates dropped to 0% after 15 min of hydrolysis (Vioque, Sánchez-Vioque, Clemente, Pedroche, & Millán, 2000).

Gelling ability

In general, all proteins can form a gel, but differences exist in the gel strengths. The ability of proteins to form gels can be measured by the determination of the least gelation concentration, which is defined as the minimal protein concentration needed to produce a gel that does not slide down the walls of an inverted tube (Moure et al., 2006). Khattab and Arntfield (2009) studied the least gelation concentrations of raw and heat-treated canola meals and reported that neither roasting nor boiling caused a significant increase in the least gelation concentration of different canola meals. This is supported by reports in the scientific literature, which show that the gelation of proteins increases with molecular weight (size) because large molecules form extensive networks by cross-linking in three dimensions (Oakenfull, Pearce, & Burley, 1997). Compared with soy and flaxseed meals, canola meal required the highest concentration for gelation regardless of the treatment used.

To improve the function of canola proteins in gel-like food systems, different additives can be combined with these proteins to make convenient gels. In this context, a study has been reported in which the thermogelation properties of a canola protein isolate in a mixed system with κ-carrageenan (κ-CAR) were studied using dynamic rheological testing. The gel properties were evaluated under different conditions, such as pH, NaCl, and κ-carrageenan and canola protein isolate concentrations. The factorial and response-surface optimization models were used to identify the processing conditions that would result in CPI–κ-CAR gels with maximized G' values (>44,000 Pa) and minimized tan δ values (0.01–0.11). According to the results, it was found that canola protein–carrageenan gel formation was strongly pH-, salt ($NaCl$)- and κ-carrageenan concentration-dependent (Unakpa & Arntfield, 2004). The reported results indicated that the optimum conditions for CPI–κ-CAR gels were pH 6, 0.05 M $NaCl$, 3% κ-CAR and 15% CPI. Samples prepared at pH 6 showed high G' (95,665 Pa) and low tan δ (0.15) values. High G' values indicate stronger intermolecular networks and increased protein–protein and protein–polysaccharide interactions, while low tan δ values indicate a more elastic network. A synergistic behavior between CPI and κ-CAR was observed with superior network strength (high G' values) for the mixed gels at temperatures above 80 °C. Furthermore, the gels showed improved network structure (low tan δ values) during the heating and cooling phases. The canola protein–κ-carrageenan mixtures

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