Comparative Study of Foaming Activity of Albumin-Rich Lupin Protein Isolates via Electrical and Volumetric Measurements

V. T. Papoti, T. D. Karapantsiosa*, G. Doxastakis

*School of Chemistry, Aristotle University of Thessaloniki, Univ. Box 116, 54124 Thessaloniki, GREECE

INTRODUCTION

Plant proteins are progressively used as foaming agents for the nutritional supplementation and technological improvement of foods. Their foaming performance depends on a number of factors; proteins’ origin (seeds variety, growth conditions-environmental, cultivation techniques etc), isolation methods, isolates’ composition & properties (e.g. solubility), as well as characteristics of the employed final solution employed for foam formation. Lupin, is among others, a promising plant protein source that has gained attention due to its nutritional and functional characteristics [1]. A key parameter for the favorable reception of a plant protein’s use is to achieve the appropriate conditions required to yield a satisfactory foaming performance. The latter, essentially refers to foam ability (capacity of the continuous phase to include air) and foam stability (ability of the continuous phase to retain air for a period of time). In the present study the foaming performance of a prototype albumin-rich lupin protein isolate (LPI) known to be a potent foaming agent is examined. Foam ability and foam stability are assessed by simultaneous local electrical conductance measurements and global volumetric record. The employed non-intrusive electrical conductance technique provides on-line monitoring of the foam drainage from all possible views of the test vessel [1,2]. In this study the effect of pH, protein’s and polysaccharide’s concentration in the resulted protein foam is examined.

MATERIALS & METHODS

The foaming performance of LPI is examined at different concentrations (1, 1.5, 2 % w/w), pH (5.2, 7.0) values and in the presence of xanthan gum (XG 0.1, 0.15, 0.2 % w/w). Before foam production the insoluble protein aggregates are removed by centrifugation. Foams are created by intense whipping. Measurements include the determination of (a) the local liquid fraction at different heights (employing 3 probes SD, LD & LU) along the foam by a non-intrusive electrical conductance technique and (b) the global liquid fraction of the entire foam column computed from volumetric measurements of the drained liquid and the foam volume. Electrical measurements are performed using ring-shaped metallic electrodes, flush mounted along the internal test vessel wall [1, 2].

RESULTS & DISCUSSION

pH is known to alter the configuration of the protein molecules, consequently affecting the production capacity and stability of foams. Data showed that the foam (1.5% w/v LPI & 0.1% w/v XG) at pH 5.2 was slightly better in terms of foambility but substantially better in terms of foam stability (Fig. 1) in comparison to the respective one at pH 7.0. At pH 5.2 protein molecules are near their isoelectric point and so they are in a compact form in the bulk solution. Therefore, although they do not adsorb easily at the interface, they are absorbed in compact configuration providing a higher concentration of protein molecules per unit area of interface and consequently a larger number of interlinkages per unit area than at other pH values [3].

An interesting behavior was observed as protein concentration increased at a fixed value of pH (5.2) and xanthan gum (0.1% w/v). Foamability increased monotonically with protein concentration. Yet, foam stability was clearly better at the intermediate LPI concentration examined (Fig. 1). According to literature [4], in some systems there is a critical protein concentration above which viscoelasticity drops as a result of slip planes in the interfacial film involving coagulated or native protein molecules. A common way to avoid rising the concentration of protein beyond this critical value is by adding foam stabilizers [5].

When XG concentration increased foamability got slightly worse but foam stability was markedly enhanced (Fig. 1). Polysaccharide’s presence increases the aqueous phase viscosity which, on one hand, does not allow easy air capture during whipping but, on the other hand, reinforces the foam structure and so delays drainage. However, recent evidence supports that polysaccharides may interact with proteins at the interface affecting the interfacial rheological
properties of the system. Protein-polysaccharide interactions in the bulk solution and at interfaces are sensitive to (a) details of protein and polysaccharide structures, (b) their respective concentrations and (c) pH. Therefore, as protein concentration increases in the presence of polysaccharides, foam films may or may not encounter an optimum viscoelasticity depending on the employed conditions [5].

CONCLUSION

The employed electrical conductance technique was characterized by satisfactory sensitivity and accuracy for the detection of temporal and spatial variations in foams and can be easily implemented for real-time monitoring of industrial foam production processes. Electrical measurements were generally found in agreement with conventional volumetric determinations. Whereas, as the foaming ability determination is concerned the two techniques were complementary one to another since electrical measurements can deliver local information of foam behavior that volumetric measurements can not capture. The optimum combination of parameters of a protein solution (such as pH, protein’s & polysaccharide’s concentration) that yield the best foaming performance should be each time carefully designed. In the present case, at pH 5.2 near the protein’s isoelectric point better foaming performance was achieved. Increase in XG concentration resulted to be better stability but slightly worse foamability, whereas interestingly, the effect of LPI concentration was not monotonic. The foaming performance of the albumin rich lupin protein isolate studied was best at the examined intermediate concentration.

ACKNOWLEDGEMENT

Financial support by the European Space Agency through the project FASES (ESA-AO-2004-PCP-109/ELIPS-2) is gratefully acknowledged. This work is conducted under the umbrella of the COST P21 action: Physics of Droplets.

REFERENCES