J. Dairy Sci. 89:951–962

Rheological Behavior and Organoleptic Effects of Ovalbumin Addition in Yogurt Mousse Production

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ABSTRACT

Yogurt mousse is a novel, high added-value dairy product that has been well received by the market. This paper presents a study of the effect of the addition of ovalbumin to the product on its rheological and organoleptic qualities. The ovalbumin was previously separated from egg white with a high grade of purity using an ion exchange resin synthesized by the authors. Diverse rheological tests at different temperatures and corresponding sensorial assessments were conducted to compare samples without and with added ovalbumin.

The obtained results confirm that the product is viscoelastic and combines the properties of foams and emulsions; the elastic component is greater than the viscous component. Moreover, at temperatures ranging from 5 to 15°C, a usual interval of consumption, the product behaves rheologically in a similar way. Conversely, the addition of ovalbumin under the assayed conditions also makes the elastic character of the product increase at a given temperature. Finally, the sensorial assessment tests and determinations of stability and volume yield enabled us to verify that the addition of ovalbumin at an amount of 1.3% hardly alters the stability, resistance to shear stress, or the texture and improves the degree of foaming. Therefore, the product with additive is of good commercial quality.

Key words: mousse, yogurt, ovalbumin, rheology

INTRODUCTION

One of the most useful tools for studying the texture of products, both in cosmetics and in pharmaceutical and food products, is rheology (Steffe, 1996; Guerrero et al., 1998; Gallegos and Franco, 1999; Langevin, 2000). Rheology and the study of elastic and viscous behaviors are also used to investigate more complex systems, which in turn present intermediate properties by virtue of their composition and structure (i.e., they are viscoelastic substances). Within this group, dairy gels are included (Everett and Olson, 2000; Koh et al., 2002).

The dairy industry is continuously developing novel products, especially fermented desserts, of a more or less sophisticated texture and with great added value. The flow properties of these new products, among their other properties, are being studied (Pintado et al., 1998; Abu-Jdayi and Mohameed, 2002). A recent example has been the introduction on the European market of yogurt mousse. Yogurt mousse is an interesting viscoelastic product that combines the properties of emulsions and foams (Paredes et al., 2004); its commercial success is based on these qualities, which are fundamentally related to its appearance and texture. Rheometry is the most valuable tool for studying the properties of this product.

Moreover, for both economic and environmental reasons, new materials and procedures have been developed in recent years that are aimed at the separation and use of proteins from by-products or from raw materials of little value. One of the separation techniques is ion exchange chromatography, which has given rise to substantial developmental research relative to new materials (Paredes et al., 2001, 2003, 2004). In the egg product industries, a highly pollutant waste results from the cracking of the shell. The waste is fundamentally made up of the shell (approximately 10% of the weight of the hen's egg) and its corresponding membranes and residual egg white adhered to the inner surface. However, the environmental problem generated by the egg industry is not as important as the problem generated by the whey in the dairy industry; however, it must be considered so, as it represents a problem for the egg derivate industries. This residual egg white contains different proteins, such as ovalbumin (molecular weight = 45,000 Da), which presents good emulsifying and foaming properties (Galazka et al., 2000; Huntington and Stein, 2001). This makes it suitable for use in products in which this quality is one of the main commercial assets. The stability of foams is increased by raising the viscosity of the dispersion phase, decreasing the tension of the interfaces with the aid of foaming agents, and increasing the electrostatic charge and the elasticity of the liquid films.

Received July 26, 2005.
Accepted October 18, 2005.
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Table 1. Main physical characteristics of the synthesized resin for egg white protein separation

	Thermal stability limit (°C)	D(4,3) (μm)	D(v,0.5) (μm)	N content (%)	Specific surface area (m^2/g)	Most frequent pore diameter (nm)	Permeability (cm^2)	Equilibrium constant[1]	Protein retention capacity (mg/mL)
MC/DMC resin[2]	200	180	177	1.74	63	12.9	1.5×10^{-10}	10	15
Q-HyperD[3]	150	55	50	2	ND	Pore filled with gel	1.0×10^{-8}	4	80

[1]Calculated using the constant separation factor isotherm.
[2]MC/DMC = Methacrylate/dimethacrylate.
[3]BioSepra (Pall Corp., East Hills, NY).

From previous works carried out by the authors (Paredes et al., 2001; Suárez et al., 2002; Paredes et al., 2003) using new poly(glycidyl methacrylate-co-ethylene dimethacrylate) anionic ion exchange resins to separate, in an economic way, the proteins from wastes of food industries and employing a simple rheological study with different formulations of yogurt mousses (Paredes et al., 2004), the objectives of the present work were 1) to separate, with good efficiency and purity, the ovalbumin contained in residual egg whites from the egg product industries, and 2) to verify that the obtained ovalbumin could be incorporated into yogurt mousse without any textural and organoleptic changes to the final product. If so, this process could translate into some economical profit.

MATERIALS AND METHODS

Synthesis and Characterization of the Resin

Because commercial resins for separating proteins by ion exchange are really expensive, in this study, a poly(glycidyl methacrylate-co-ethylene dimethacrylate) resin developed by the authors was used (Paredes et al., 2001; Suárez et al., 2002; Paredes et al., 2003, 2004). Table 1 shows the values of the most important parameters of the developed resin.

The synthesized groups found in the resin are related to the nitrogen content. The result of the elemental analysis revealed a value equivalent to that of other, similar resins (Stanley et al., 1996). The main advantage of this resin is the low cost of manufacturing compared with commercial resins. For example, the cost to obtain 1 g of ovalbumin with the methacrylate-based resin is near $7, and by using a commercial resin, such as Q-HyperD (BioSepra, Pall Corp., East Hills, NY), the cost is increased to ~$7.50. Characteristics of a good, well-tested commercial resin are also presented in Table 1 for comparison with the resin used in this work. The commercial resin presents better capacity and a lower equilibrium constant; the main disadvantage of this resin is its high economical cost and the high pressure drop when it is packed in chromatographic columns (Rendueles de la Vega et al., 1998).

Prior Conditioning of the Egg White

Hen eggs were purchased from a local market. Conditioning was carried out with the goal of removing ovomucin from the egg white; otherwise, it would interfere with the normal flow through the column. The method used was the one referred to elsewhere (Croguennec et al., 2000), which employs nontoxic reactants. The mucin-free egg white supernatant obtained was then dried at 30°C under vacuum in a Savant Speed Vac SPD 111 V device (Savant Instruments Inc., Holbrook, NY) until its use.

Chromatography and Electrophoretic Characterization

The separation of ovalbumin was carried out on a column scale using the techniques indicated previously. The yield was similar to that obtained by others employing commercial products (Vachier et al., 1995; Shibusana et al., 1998; Awadé and Efstathiou, 1999; Croguennec et al., 2000). The fixed bed-scale trials were conducted using a 32-mm internal diameter Vantage borosilicate glass column (Millipore Bioprocess Division, Stonehouse, UK) loaded by dynamic compression (Stanley et al., 1996) with 23 mL of resin, presenting a final density of 0.43 g/mL. The solution, introduced by means of a Masterflex 7554-60 peristaltic pump (Cole Palmer Instruments Co., Chicago, IL), had a concentration of 5 mg/mL and was buffered in Tris·HCl 10 m*M* (pH 7.6). Stepwise gradient elution was carried out employing a solution of 0.5 *M* NaCl. After the final elution, the column was washed with 5 vol of said solution (Panreac, Montplet and Esteban S.A., Barcelona, Spain) and was then reconditioned using the Tris·HCl 10 m*M* buffer (pH 7.6). The concentration of proteins at the column outlet was analyzed by means of an Rd UV-