AEB Final Report

Project title: Effect of Yolk Contamination, Shearing, and Heating on Foaming Properties of Egg White

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Overall Project Objectives as listed in the proposal:

1. To determine correlation of two foaming methods;
2. To examine the effect of lipid contamination on foaming properties of egg white;
3. To improve foaming of the yolk-contaminated egg white;
4. To study the effect of shearing and heating on foaming of the egg white;
5. To explore the mechanism of foaming reduction by lipid, shear and heat.

We have published two manuscripts in the **Journal of Food Science**, presenting data to answer above questions. As an executive summary, we have found:

1. The whipping method is a better and more sensitive method than N_2 purging method in measuring foaming.
2. Comparing the effect of polar vs. neutral lipids contained in the yolk, neutral lipid is much more damaging to foaming than polar lipid.
3. We have tested different physical (e.g. entrapment of lipids) and chemical (e.g. enzymatic and caustic hydrolysis of the lipids) means to remove the effect of lipids, and we have developed an effective means to restore foaming of yolk-contaminated albumen protein. We have made an alkaline protein and demonstrated that the interaction of generally acidic native protein with the oppositely charged alkaline protein can restore foaming.
4. Shearing had minimal effect on foaming, and heating as commonly encountered in the industry did not significantly damage foaming. The samples collected from a processing plant actually showed improved foaming after various unit operation steps.
5. As stated above, neutral lipid had more significant effect on foaming reduction than the polar lipid, and it does so by interacting with the non-polar portion of the proteins, preventing the hydrophobic interaction among the protein molecules, which is the main mechanism of forming visco-elastic film with good strength and stability.

The two abstracts as presented below further summarize the main results we have obtained. The full description of the research is shown in the two attached published papers.

Impact of the research funded by AEB:

1. When presenting our research at conferences in the US, Europe, and Asia, we have received great interest from the industry and further requests on proving more information and possible collaboration on using the foaming enhancement technology.

2. With the promising results in albumen model system, we (co-PI Dr. Reitmeier, professor of FSHN, ISU) have successfully obtained funding from Midwest Poultry Research Program, and we are continuing the research on testing the effectiveness foaming enhancement in the food/baking systems.

Thank you very much for supporting our research. We hope the results we obtained will provide the egg industry with great insight in improving processing efficiency and creating value-added and functionality-enhanced egg products.

Abstract 1: Effects of Yolk Contamination, Shearing, and Heating on Foaming Properties of Fresh Egg White

A manuscript published in **Journal of Food Science**

A series of experiments were conducted to evaluate effect of yolk contamination, shearing, and thermal treatment on foaming properties of liquid egg white. Samples obtained from industrial processing were also evaluated. Whipping and purging methods were both used to assess their effectiveness and sensitivity in evaluating foaming. A concentration as low as 0.022% (as-is basis) of yolk contamination caused significant reductions in foaming capacity and foaming speed. The neutral lipid fraction of egg yolk caused the major detrimental effect on foaming, and phospholipids fraction did not give significant foaming reduction at a concentration as high as 0.1%. High speed and short time shearing caused no apparent damage but longer shearing time significantly impaired foaming. Heat-induced foaming change is a function of temperature and holding time. Foaming was significantly reduced at temperature of 55 C for 10 min, whereas it did not change up to 3 min at heating temperature of 62-64 C. Industrial processing steps (pumping, pipe transfer, and storage) did not produce negative effects on foaming of the final products and the controlled pasteurization was actually beneficial for good foaming performance. Therefore, yolk contamination of the egg white was the major factor in reducing foaming properties of the white protein.

Abstract 2: Improving Foaming Properties of Yolk-Contaminated Egg Albumen by Basic Soy Protein

A manuscript published in **Journal of Food Science**

Yolk contamination of egg white is a common problem in the egg breaking industry. Foaming properties of egg white protein are affected by such contamination, but proteins of basic nature may restore the foaming properties of the yolk-contaminated egg white protein. The purpose of this study was to chemically modify a soy protein, i.e. to esterify the acidic groups on the protein, and to study the potential of such modified protein in improving foaming. We showed that the modification changed the isoelectric point of soy protein isolate (SPI) from 4.5 to about

10. Sonication was proven to be a very effective means to re-disperse the methanol-denatured soy protein during reaction, as shown by the improved solubility profile. Such modified basic protein, i.e. the sonicated-modified SPI (SMSPI), when added to the yolk-contaminated (at 0.4% level, as-is basis) egg white, gave significantly improved foaming properties. We have shown that the slight change in pH due to the addition of SMSPI was not the reason for improved foaming performance; instead the modified protein itself was the main reason for such improvement. Addition of SMSPI increased the foaming performance of both pure egg white and yolk-contaminated egg white. SMSPI consistently performed better than the unmodified SPI for improving foaming. Addition of SMSPI (16%, based on dry egg white, and 1.6% based on liquid egg white) fully restored foam expansion and foam liquid stability of 0.4% yolk-contaminated egg white, and it even out-performed the foaming of pure white protein. Therefore, a feasible solution to restore the foaming properties of yolk-contaminated egg white has been identified. It is expected that such modified SPI can be used as an additive or ingredient in foaming formulation, especially when the egg white protein is suspected of lipid contamination.