Impact of bird age on the functionality of eggs from current layer strains

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Summary
Whipping inconsistency in breaker eggs is a problem that continues to plague the egg breaking industry. Previous research shows that as the bird ages it can impact egg composition; however, to date no research has been conducted that evaluates the quality, functional, and biochemical characteristics of the egg throughout an entire two year laying cycle including a moult. This research allows an evaluation of albumen production to the resulting functional properties of current commercial layer strains. Strains were monitored under identical rearing and environmental conditions throughout the test and hens were provided nutrients to meet the needs of all the hens based upon compilation of the breeder recommendations. Monthly, the functional properties of the individual parts of the egg such as albumen (angel food cake), yolk (mayonnaise), and the egg as a whole (sponge cake) were measured. Only the first year of the production will be discussed in this paper. Bird age had a significant impact (P<0.05) on all three of the tests conducted. As the bird aged, the angel food cake volumes differed from the highest volume of 339.33 mL in period 1 to the lowest volume of 270.60 mL in period 12. Emulsion strength of mayonnaise was impacted by bird age, that difference was more prominent during the first 5 months of production (386.05 to 512.03 g), but lessened as emulsion strength increased and stabilized during the last 7 months (438.54 to 508.91g). The greatest impact in functional properties of the egg was seen on sponge cakes. These volumes ranged from 307.93 to 356.90 mLs. This erratic behaviour could explain the variability in whipping consistency seen in breaker eggs; however, the second year of the production cycle needs to be completed and evaluated before any definite conclusions can be drawn.

Abstract
In the modern commercial environment, breeding layer strains for production of large egg sizes to enhance yield is ongoing. However, effects of such breeding efforts on the functional properties of eggs, particularly foaming properties of the albumen from those eggs, has not been studied. Eggs from layer strains bred for optimal albumen production may produce characteristics that detrimentally affect the foaming property of the albumen. Currently many breaking operations have seen such whipping problems. A method to study these problems is to correlate strains of layer hens bred for the egg breaking industry to the functional characteristics of resulting egg.

The strains that were utilized were Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, ISA White, and Bovans White. These strains were selected based upon their egg weight, availability, and market share. The eggs from these strains were collected monthly from the 35th North Carolina Layer Performance and Management Test in which performance of the strains was monitored under identical rearing and environmental conditions throughout the test. The hens were provided nutrients to meet the needs of all the hens based upon compilation of the breeder recommendations. Once collected, the functional properties of the eggs such as foaming and emulsification were tested utilizing angel food cake (albumen), sponge cake (whole egg), and mayonnaise (yolk).

Bird age had a significant impact (P<0.05) on the functional properties of eggs. The greatest impact was seen on the cake volume of sponge cakes. These volumes ranged from 307.93 to 356.90 mL. Less variability was observed with angel food cake volumes (265.83 to 339.33 mL). The emulsification strength of mayonnaise was affected by bird age early on (386.05 g), but as the bird aged it had less...
of an impact (508.91 g). These findings support the current problems stated by breaking operations and help begin to identify factors impacting functional properties.

Introduction
Foaming properties of egg albumen are affected by many factors, including pH, additives, physical treatments, viscosity, and temperature (Yang and Baldwin, 1995). However, the more likely factor for poor foaming properties of fresh, frozen or commercially processed eggs (St. John and Floc, 1931) has long been attributed to the presence of lipid, usually yolk lipid, introduced during the breaking step of the egg albumen production process.

In the modern commercial environment, breeding layer strains for production of large egg sizes to enhance yield is ongoing. However, effects of such breeding efforts on the functional properties of eggs, particularly foaming properties of the albumen from those eggs, has not been studied. Eggs from layer strains bred for optimal albumen production may produce characteristics that detrimentally affect foaming property of the albumen. For example, eggs may be more susceptible to breakage of yolk membrane and contamination of albumen by yolk lipid. Because of poor foaming power of the resulting product, economic advantage of such breeding programs may be negated.

A method to study these problems is to correlate strains of layer hens bred for the egg breaking industry to the quality, functional and biochemical characteristics of resulting egg components of shell, albumen and yolk. This research project allows an evaluation of layer hen breeding characteristics production for albumen production to the resulting functional properties of those eggs.

Materials and methods
The strains that were utilized in this study were: Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, ISA White, and Bovans White from the 35th North Carolina Layer Management and Performance Test by Anderson (2004). These strains were selected based upon their egg weight, availability, and market share. The breaker market is looking for strains that will produce larger eggs. This would increase the throughput for any given breaking machine. The eggs from the selected strains have these characteristics. In addition, some of these strains hold a significant market share of the current production flocks.

Three flats of eggs were collected from the five different strains of breaker eggs. Samples were collected starting in May 2003 and subsequent samples were collected every 28 days for a 12-month period. Upon arrival the eggs were further divided into two separate flats. One flat per strain was used to conduct albumen and yolk functionality tests; the other flat was used to conduct similar tests on whole eggs. The albumen, yolk, and whole egg from six eggs were separately pooled, mixed thoroughly, and then functionality measurements were taken.

Three replicates/six eggs/strain/period were stored at 4 C overnight and broken out the following day. The albumen, yolk, and whole egg from the six eggs were separately pooled and then pooled samples were homogenized for 30 seconds using a Hamilton Beach Drink Mixer and used for the corresponding functional tests. A modified procedure by Cotterill (1986) was used to prepare angel food cakes. Sponge cakes were also prepared using the method outlined by Norris and Cotterill (1986). Both angel food and sponge cake volumes were determined via rapeseed displacement. Mayonnaise testing was conducted to evaluate yolk emulsions using the method of Guerrero and Ball (1994). Force measurements of the fresh mayonnaise were determined using the Texture Analyzer TA-XT2i using a 25mm cylindrical probe and a test speed of 1mm/second.

Results and discussion
Albumen foaming properties were evaluated using angel food cake volumes. Angel food cake volumes were not significantly different (P>0.05) in periods 1, 2, 3, 5, 7, and 8 (Figure 1). However, period 4 was significantly lower (P<0.05). During period 4, birds were diagnosed with Osteomalacia, which is related to Osteoperosis, Rickets, etc. Birds were treated initially with vitamins A, D, E, and K, supplement administered in the water, and 5 g of oyster shell/hen was top dressed in the feeder. The hens are still being supplied with 50% of their Ca in the form of oyster shell to provide for a slow release Ca during shell formation. The feed was also analyzed for vitamin content since Ca and P were normal. However, production and mortality rates returned to normal by sampling period 5. As the bird continued to age the angel food cake volumes differed (P<0.05) from the highest volume at 334.56 mL in period 8 to the lowest at 270.60 mL in period 12, indicating that bird age negatively
affected albumen foaming properties. Findings by Izat (1983) and Cunningham et al. (1960) tend to support this conclusion. They reported that the percentage of albumen solids, albumen protein, and Haugh units decreased with the age of the bird. Both studies also stated that as hens aged the albumen quality traits worsened and yolk traits generally improved.

**Figure 1: Effects of bird age on angel food cake volumes.**

The greatest variability in functional properties of eggs was found with whole eggs in sponge cakes. Sponge cake volumes changed erratically (P<0.05) with volumes starting out low at 318.40 mL in period 1 to a high of 356.90 mL in period 7 and then dropping down to 307.93 mL in period 11 (Figure 2). When looking at the variation among strains (Figure 3) a significant difference (P<0.05) was found between Hy-Line W-36 and Hy-Line W-98. These 2 strains are the most commonly used strains in the egg breaking industry, which could explain the inconsistency in whipping/foaming behaviour that they are reporting.

**Figure 2: Effects of bird age on sponge cake volumes.**
Emulsion strength of mayonnaise was impacted by bird age ($P<0.05$) during the first 5 months of production (386.05 to 512.03 g), but that impact lessened as emulsion strength increased and stabilized during the last 7 months (438.54 to 508.91 g) (Figure 4).

All of the differences in albumen and yolk functionalities are definitely contributing to the variability in whipping properties that continue to plague the egg breaking industry. It is too early to say what definitive impacts these ages are having until the second year of this research project can be completed and evaluated. For supporting information regarding the quality and composition
characteristics of these eggs please refer to the companion paper presented at this symposium by Curtis et al. entitled “Quality and Compositional Characteristics of Layer Hens as Affected by Bird Age.”

Reference


Izat, A.L. (1983) The effects of age and season on selected quality characteristics of shell eggs from several strains of commercial layer hens. M.S. Thesis, Texas A&M University, College Station, TX.

