Evaluation of Degradation of the Chicken Egg Over Time By Method of Haugh Unit Score

A Senior Project

presented to

the Faculty of the Animal Science Department

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Bachelor of Science

by

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Abstract

The purpose of this senior project was to measure the degradation of the chicken egg over time under different treatments. 864 eggs were collected and divided into six treatment groups. The six groups of study were refrigerated: unwashed, washed, washed and oiled as well as room temperature: unwashed, washed, washed and oiled. The Haugh unit score was measured individually for one dozen eggs taken randomly from each of the six groups once a week for twelve weeks. The Haugh unit score statistical assessment of the eggs found washed and oiled eggs held in refrigeration maintain freshness longer than the other methods. Refrigerated, washed eggs are currently the industry standard in the United States.

Acknowledgments

I greatly appreciate those who manage and are involved with the Cal Poly Poultry Unit. The students operating the egg-processing center were instrumental in helping me acquire the large amount of washed and unwashed eggs for this project. I thank Dr. Robert Spiller for his assistance in helping me plan and execute this senior project. I could not have completed it without his endless knowledge of the poultry industry. Also, I would like to thank Dr. Schaffner of the Statistics department for his knowledgeable as well as his enthusiastic and helpful assistance in organizing my data in a statistical fashion.

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Introduction

In the United States, it is federally required that United States Department of Agriculture (USDA) graded eggs be washed and sanitized before being sold to consumers. This method helps prevent fecal and foreign materials from entering the food supply and causing foodborne illness. When washing eggs, the wash water must be at least 20°F warmer than the internal temperature of the egg, or 90°F. If the wash water is cooler than the internal temperature of the egg, the internal contents can contract; drawing bacteria and pollutants in through the porous eggshell. If this occurs, the egg becomes an incubator for the multiplying bacteria, especially if it is left at room temperature and not refrigerated immediately.

Egg producers in the European Union, however, are mandated to "not wash or clean in any way" the Grade A eggs sold to consumers. They are also not refrigerated before consumer purchase. Mark Williams, the Chief Executive of the British Egg Industry council states that, "this practice promotes good animal husbandry on farms since it is in the producer's best interest to produce the cleanest eggs possible, as no one will buy them if they are dirty." Likewise, it is believed that refrigeration of eggs before consumer purchase can run the risk of the eggs "sweating" in the time it takes the consumer to buy the eggs and take them home to their refrigerator. This produces a small water layer on the outside of the egg that allows the possible bacteria present on the shell to begin growing. This poses a threat when the consumer allows the external shell of the egg to contact the internal contents or handles the shell of the egg and then proceeds to handle other uncooked food items that can also harbor the bacteria.

Another important aspect to a chicken egg is the naturally produced cuticle covering the exterior of the egg just prior to the egg being laid by the hen. The eggshell is a porous membrane containing approximately 7,500 pores. This allows the egg to exchange gasses with the environment to maintain its equilibrium. When the egg is washed, the cuticle is removed and sometimes replaced with an edible mineral oil before packaging. The edible mineral oil acts as a man made cuticle that helps prevent dehydration of the egg as well as the entrance of bacteria. When the egg is laid at 105°F, an air cell is created in the large end of the egg between the inner and outer membranes as it cools. This formation is a result of the variance in the rates of contraction between the eggshell and its interior. Over time the quality of the egg decreases as the yolk absorbs water from the white. Subsequently, the air cell of the egg grows in size due to an influx of air as moisture and carbon dioxide diffuse through the porous shell. This occurrence becomes more rapid over time as a result of the degradation of the vitelline membrane which separates the white from the yolk; resulting in a more easily broken yolk and a lower Haugh score. A Haugh unit score of 72 and greater correlates with an USDA egg grade of AA, A grade falls within the range of 60-72, and B grade is below 60.

As cited by in a previous study on egg quality, the most heavily weighted factor effecting the albumin quality of an egg is the age of the hen that laid it. This is an important factor to consider in this study, as the hens were just prior to molting and 68 weeks of age when the eggs were collected for this study. Therefore, their Haugh Unit scores were expected to be lower than the same group of hens following molt, though they are of acceptable production age. This source also relates that it is of importance that the eggs are cooled directly after lay and held at low temperatures subsequently, near but not below 32°F. Also, oiling of the eggs within 24 hours of

lay is effective in retarding degradation of the Albumin, but still requires cool storage. In consistence, another study found that Haugh unit score decreased with increased storage time, hen age, and temperature.

Objectives

My goal in this Senior Project was to determine how long the egg takes to degrade over time under various conditions. I compared the European Union's (unwashed, unrefrigerated) and United States Department of Agriculture's (washed, sometimes oiled, refrigerated) methods for egg processing and handling to attempt to quantify which method prevents decay for the longest amount of time.

Materials and Methods

I gathered 864 eggs from the Cal Poly poultry unit on April 24, 2012. They were divided into three groups as follows: unwashed, washed and washed and oiled (with an edible mineral oil). These three groups were then each divided in half to allow one set of three to remain at room temperature (60°F ±2°F) and the other set to be refrigerated (36°F ±2°F). This resulted in 144 eggs being placed under each of the six conditions. These eggs were all within the range of class size large to jumbo with individual weights between 56.7-70.8 grams, respectively.

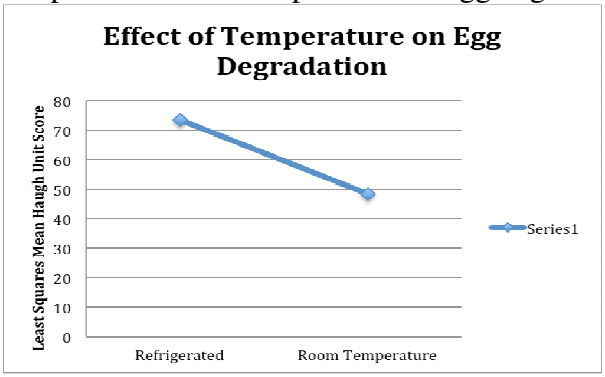
Once a week for the following 12 weeks, the Haugh unit scores of one dozen eggs from each of the six procedures were measured and recorded. As the 12^{th} week neared, some eggs became rotten, yielding a 0 Haugh unit score due to the complete degradation of the thick albumin. They were not excluded from the data collection or data computations.

Each individual egg was weighed on a gram scale and the weight recorded in grams. The egg was then broken out onto an elevated glass sheet that was cleaned between each use. The midpoint of the thick albumin of the egg was measured with a tripoid micrometer yielding a value with units of millimeters. This recorded value along with that of the weight was then correlated using a Haugh meter to give a Haugh unit score.

Analysis and Results

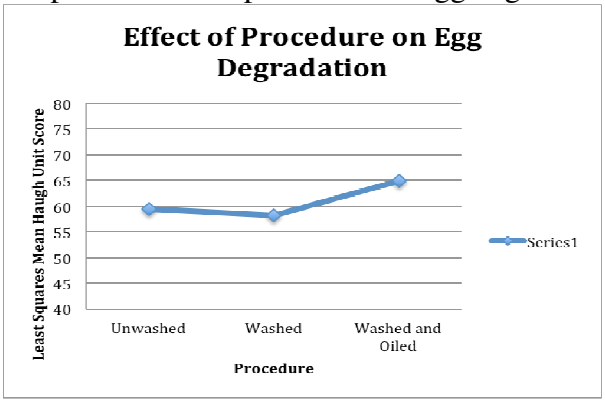
The statistical analysis of the raw data supports the USDA's requirements for selling graded eggs in that the refrigerated, washed and oiled eggs postponed degradation the longest. Of the variables: time, temperature, procedure (unwashed, washed, washed and oiled); time and temperature were factors of optimum importance due to a large sum of squares. Likewise, the procedure component had a small sum of squares, making it of less importance in egg handling. This is also exhibited pictorially through the use of graphs below. The P value was < 0.05, making all differences across the procedures significant.

Graph 1: Effect of temperature on egg degradation



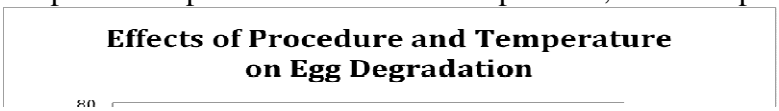
Graph one exhibits the least squares mean of the refrigerated and room temperature eggs over the twelve week period. The room temperature eggs degraded more quickly than those that were kept refrigerated.

Graph 2: Effect of procedure on egg degradation



Graph two compares the least squares mean of unwashed, washed, and washed and oiled eggs from both temperatures collectively throughout the twelve week period. Again, washed and oiled eggs performed better than either unwashed or washed, regardless of temperature.

Graph 3: Comparison of affects of temperature, time and procedure on egg degradation



Discussion and Conclusion

Overall, this experiment showed that providing an egg with a replacement cuticle after being washed as well as refrigeration prolongs the edible life of the egg. The next best procedure for egg handling is unwashed, refrigerated eggs. In this instance, the natural cuticle is maintained on the shell and bacteria prevented from entering, while internal moisture is prevented from exiting. According to my research, both of these previously mentioned procedures perform better than the procedure in which only washing is used, regardless of temperature. Guaranteed, refrigeration greatly increases the edible life of the egg as opposed to storage at room temperature.

While the industry standard in the United States is to wash and refrigerate eggs for distribution to consumers, producers are not required by the USDA to oil the eggs with an edible mineral oil. As shown by the research, once eggs are washed it is beneficial to oil them in order to prevent degradation. However, because expiration dates of eggs can be no more than 30 days from the day the eggs were packed, and the Haugh unit scores did not begin to drop below A grade until week 11, it is not necessary for the industry to take alarm at this finding.

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