DESCRIPTION OF PROBLEM

In 2009, the Grading Division of the Agricultural Marketing Service’s Poultry Programs (the egg and poultry voluntary grading section of the USDA), initiated a retail egg quality survey to collect data on eggs being sold to consumers. The purpose of this survey was to assess the quality of eggs distributed in commerce, to determine their consistency with current USDA standards, and to compare the results of this new survey with those of an outdated egg quality survey conducted in September and October of 1990 [1]. The survey was conducted during the late spring and summer months when quality is generally understood to be at the lowest level. The process consisted of visiting 123 supermarkets and convenience stores nationwide. Each store was visited multiple times during the 4-mo period for a total of 1,235 visits across all stores. A total of 5,288 samples (of 100 eggs each) representing 265 different brands were selected.
and examined by USDA-licensed egg inspectors using standard hand candling methods to determine each sample’s quality. Based on the data collected, the overall internal and external egg quality marketed at retail stores has significantly improved since the previous survey [2]. Of particular interest, one nationally marketed specialty brand of eggs (brand A) consistently exhibited higher quality levels than the other brands. To validate the results of this USDA survey, the brand A specialty egg company conducted a separate quality and freshness study in collaboration with IEH Laboratories and Consulting Group [3], an independent accredited food testing and analytical laboratory.

Brand A eggs are required to be produced under strict standards that focus on product safety, quality, nutritional enhancement, and sensory appeal. Whereas all of these factors are important for a superior product and the continued growth of the product line, it has been demonstrated that the basic qualities characteristic of a fresh egg are those that are the most readily perceived and valued by the consumer; these include flavor, visual attributes typically associated with egg freshness [i.e., a thick, cohesive egg white (albumen), and a firm yolk that does not easily rupture] [4]. To consistently provide these fresh egg qualities for consumers, producers of brand A eggs must adhere to strict production and processing standards regarding flock nutrition and welfare and methods of egg processing, storage, and transportation. To validate that all of the standards have been implemented, the brand A egg company monitors product quality on an ongoing basis, requires that each producer’s product and practices be subjected to third-party evaluations, and solicits and responds to all consumer comments regarding quality and freshness. The brand A egg company additionally conducts retail quality studies of its eggs as a final validation of overall product quality.

The objective of this study was to determine, through an independent evaluation comparing the quality of brand A specialty eggs to that of standard generic eggs, (1) if implementing enhanced production and processing standards for brand A eggs results in higher quality eggs than generic eggs when they reach retail establishments and (2) if brand A egg quality remains higher than that of generic eggs over an extended time frame.

**MATERIALS AND METHODS**

**Brand A Egg Production and Processing Standards**

Brand A specialty egg production and processing follows a specific set of standards. First, sourcing of eggs from first- and second-cycle flocks is limited to 65 and 95 wk of age or less, respectively (compared with a typical maximum 80-wk cycle for first-cycle flocks). Second, the preprocessing egg storage period is restricted to 7 d, rather than allowing the 21 d permitted by the USDA (defined as eggs of current production-7 CFR Part 56 [5]). Third, every effort is made to move brand A eggs into distribution channels within 24 to 48 h of lay. Fourth, feed is fortified with the vitamin and mineral supplement Biotene (a proprietary premix that contains the basic vitamins and minerals necessary for a laying hen’s nutritional requirements, as well as exclusive levels and chemical forms of copper, manganese, zinc, vitamin E, vitamin D, organic selenium, iodine, and lutein). Utilizing specific improved chelated, hydroxyl, and organic mineral forms has been shown to reduce the risk of oxidation of important nutrients [6]. Fifth, brand A eggs are processed, packed, and officially graded under the USDA Voluntary Grading program and the brand A egg company specifies grade standards that are higher than current established USDA standards. Sixth, and finally, no animal by-products or waste products from food manufacturing or preparation (e.g., restaurant grease) are allowed in the layers’ feed.

**Egg Sample Collection and Storage**

Fifty dozen brand A specialty eggs and 50 dozen store brand (generic) eggs (all white, large, and grade A) were collected for analysis from major supermarkets in the Chicago, Illinois, area by IEH Laboratories and Consulting Group [3]. Samples of brand A and generic eggs were collected in similar date ranges and from the same store when possible. Each sample was labeled with store name, store location (street, city, state), purchase date, USDA plant code.
(when applicable), Julian calendar pack date (lot number), and sell by or best before date. All samples were refrigerated (7.2°C or lower) in the retail store and then at the analytical laboratory until evaluation. Internal egg quality tests were performed on specific days since packing (based on Julian calendar pack dates).

**Interior Egg Quality Measurements**

Egg weight, albumen height, Haugh unit value, and yolk color score were determined for all 12 eggs in each of the 100 dozen that were collected. Egg weight and albumen height were determined using an Orka Food Technology egg analyzer [7] and its procedures for operation. Haugh unit values were then calculated as

\[100 \times \log \left\{\left[-1.7 \times (\text{egg weight in grams})^{0.37}\right] + [7.57 + \text{albumen height in millimeters}]\right\}\]  

[8].

**Statistical Analysis**

Egg weight, albumen height, Haugh unit, and yolk color scores determined for all brand A eggs at each time point (days since pack) were pooled across all stores to generate a mean value for each egg parameter at each time point. The same was done for generic brand egg data. These time point means were the raw data used to generate overall means for brand A and generic eggs and to determine if these brands were significantly different for each egg quality parameter. Statistical analysis used the PROC GLM procedure of SAS version 9.2 [9] and Duncan’s test for multiple mean comparisons [10]. The time point means were also the raw data used to generate slopes of mean albumen height or Haugh units plotted over time (days since pack) so that it could be assessed if the slopes of these lines were significantly different between brand A and generic eggs. For slope comparison statistical analysis (using SAS version 9.2 [9]), the PROC REG procedure was employed to generate slopes and the PROC MIXED procedure was used to determine if slopes of the regression lines of brand A versus generic eggs were significantly different. Statistical significance was established at \( P \leq 0.05 \) for all analyses.

**RESULTS AND DISCUSSION**

Egg weight did not differ significantly between brands; however, albumen height, Haugh units, and yolk color were all significantly greater for brand A compared with generic eggs when considered across all time periods (Table 1). Differences in the slopes of regression lines of egg albumen height and Haugh units over time for brand A versus generic eggs were also assessed (Figures 1 and 2). Albumen height and Haugh units were both found to decline more slowly over time for brand A eggs compared with generic (\( P < 0.0001 \) for both parameters). It is worthwhile to note that a Haugh unit value of 72 is the demarcation for grade AA versus grade A eggs; meaning that brand A eggs maintained grade AA quality over the course of the study, whereas the generics did not (Table 1). The trend line for generic eggs also falls below the grade AA Haugh unit value of 72 at about 25 d postpacking (Figure 2), whereas the trend line for brand A eggs does not fall below grade AA even to 45 d postpacking.

It is generally understood that, in a healthy flock, the age of the layers is a major factor affecting egg quality and freshness. Because of this, younger layers will generally produce eggs of higher quality and freshness than older layers [11]. A typical maximum flock age for single-cycle hens today is around 80 wk [12]. It would seem logical that limiting the flock’s age would help to ensure that higher overall quality and

<table>
<thead>
<tr>
<th>Item</th>
<th>Egg weight (g)</th>
<th>Albumen height (mm)</th>
<th>Haugh units</th>
<th>Yolk color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand A</td>
<td>60.92</td>
<td>5.75⁰</td>
<td>74.00⁰</td>
<td>7.29⁰</td>
</tr>
<tr>
<td>Generic</td>
<td>61.35</td>
<td>5.52ᵇ</td>
<td>71.71ᵇ</td>
<td>6.03ᵇ</td>
</tr>
<tr>
<td>P-value</td>
<td>0.4241</td>
<td>0.0052</td>
<td>0.0006</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

⁰ᵇMeans within the same column with no common superscript differ significantly (\( P \leq 0.05 \)).
freshness would be consistent and maintained longer. Furthermore, egg environmental factors, such as storage time and temperature, affect the interior quality of eggs [13, 14]. Thus, establishing limits on the length of time that eggs are held before processing and packaging is also a key factor to consider for maintaining superior egg quality and freshness. Additionally, several nutritional supplements (e.g., selenium [15–17], iodine [18], manganese, copper and zinc [19], vitamin E [17], and vitamin D [20, 21]) have been shown to contribute to improved and sustained egg quality.

The brand A egg company enlists all of these managerial considerations into practice by (1) setting limits on hen age for sourcing eggs,
(2) limiting the length of time that eggs can be stored before processing and distribution, (3) fortifying hen diets with the vitamin and mineral supplement Biotene, and (4) by setting grading standards higher than typical industry levels. It is shown herein that these efforts consistently result in eggs that are superior in egg interior quality both on average (e.g., for albumen height, Haugh units, and yolk color) and when assessed over time to 45 d postpacking (e.g., for albumen height and Haugh units) when compared with generic eggs.

CONCLUSIONS AND APPLICATIONS

1. This independent retail egg quality study validates the results of the 2009 USDA survey by establishing that overall quality and characteristics indicative of freshness of brand A specialty eggs are higher and maintained longer when compared with generic eggs.

2. Furthermore, this retail egg quality study supports the concept that specific production, processing, and storage practices, in conjunction with specific nutritional supplements, result in improved egg quality and freshness attributes that are potentially recognizable and appreciated by discerning consumers.

REFERENCES AND NOTES


3. IEH Laboratories and Consulting Group, Lake Forest Park, WA.


7. Orka Food Technology, Ramat HaSharon, Israel.


