Egg quality guidelines for the Australian egg industry

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Summary
Studies were conducted to provide realistic commercial guidelines on egg internal quality and egg shell quality for the Australian Egg Industry. Eggs were obtained from commercial operations both from flocks that were followed throughout their laying life ("longitudinal studies") and also from flocks that were sampled at only one age of bird from a flock but across a range of ages of flocks ("cross-sectional studies"). Eggs were analysed for internal quality and egg shell quality as soon as possible after collection. The data collected indicate that there is considerable variation among flocks in egg and egg shell quality measurements, although there is little difference among the three main brown egg layer strains. However, consistent findings in relation to bird age were: an increase in egg weight and shell weight up to 45 and 40 weeks of age, respectively, after which these weights remained relatively constant, reduced shell colour, shell breaking strength, deformation, percentage shell, and reduced albumen height and Haugh Units. Both temperature and humidity influence the loss of weight from stored eggs whereas Haugh Units are affected mainly by temperature. Correlations were made between the laboratory measurements of egg and egg shell quality and the percentage cracks identified at a commercial grading facility.

Introduction
Problems with egg and egg shell quality continue to be of concern to the poultry industry in Australia and around the world. The egg shell quality seminar organised by the Egg Industry Research and Development Council (now the Research and Development Program of Australian Egg Corporation Limited), in July 1988, concluded that approximately 10% of eggs are downgraded because of problems with shell quality alone. Noting that the gross value of production of the Australian egg industry was of the order of $337 million per annum in 1998-1999 (AEIA Statistics), this represents a loss well in excess of $10 million per annum to the egg industry. The exact losses are not easy to estimate because of difficulty in determining the net value of the industry. Information obtained recently from egg grading facilities indicates that 10% is still a valid working figure for the percentage of eggs lost to egg shell quality problems.

Additional losses result from egg and egg shell quality problems in breeder birds. In addition to shell quality problems, egg internal quality is increasingly important to the egg industry, with supermarkets setting minimum standards for albumen quality. It is critical to the Australian Egg Industry to have available guidelines on the levels of egg shell quality and egg internal quality that can be realistically achieved in the commercial setting. Such guidelines can then be used to negotiate quality guidelines with purchasers such as the major supermarket chains.

This study documents the relationship between laboratory measurements of egg and egg shell quality, and what happens in the commercial situation. Egg internal quality and egg shell quality are described for the three brown egg layer strains commonly in use in the Australian Egg Industry, in relation to bird age.

Materials and methods
Two different types of study were conducted. The first type was the longitudinal study where individual flocks were studied at different ages. The second type was the cross-sectional study where eggs from flocks of known backgrounds were sampled, mainly from commercial grading floors. In all, 36 flocks were sampled in the longitudinal studies (9 HyLine Brown, 12 HiSex and 14 Isa Brown) with a total of 185 sampling occasions (37 HyLine Brown, 57 HiSex and 91 Isa Brown). Eighty-six flocks were sampled for the cross-sectional studies (one sampling from each flock – 35 HyLine Brown, 25 HiSex, 17 Isa, 6 Lohmann, 1 HyLine W36, 1 HyLine Gray, 1 Ingham Tint). This resulted in a total of 271 samples from flocks, each of 90 eggs – a total of 24,390 eggs (16,650 from the longitudinal studies

and 7740 from the cross-sectional studies). The flocks sampled were mainly from three strains of birds: Isa Brown, HyLine Brown and HiSex. However, limited data were collected from Lohmann Brown, HyLine W36 (white egg layers), HyLine Gray (tinted eggs), Ingham Tint (tinted eggs). Of the 271 samplings of eggs, 221 were from New South Wales, 37 from Queensland, 2 from Victoria and 11 from South Australia. Only data from the three commonly used brown egg layer strains (Isa Brown, HyLine Brown, HiSex Brown) are included here.

All eggs were analysed for egg internal quality and egg shell quality within 2 days of being laid for eggs in the longitudinal study and an average of 4.4 days for the cross-sectional study. Eggs were candled and any defects or cracks noted. Eggs were then subjected to the following measurements for egg shell quality: egg weight; shell colour (measured by percentage reflectivity – the higher the reflectivity, the lighter the colour of the shell); egg shell breaking strength (by quasi-static compression). The eggs were then broken out for measurement of internal quality as albumen height (from which Haugh Units were calculated) and yolk colour score (Roche scale). All measurements were made using equipment from Technical Services and Supplies (TSS), U.K. Egg shells were then washed carefully and dried. Shell weight was measured and the ratio of shell weight to egg weight (percentage shell) was calculated. Three small pieces of shell were taken from around the equator of the egg shell and shell thickness (including shell membranes) measured using a Mitutoyo Dial Comparator gauge.

Eggs were stored for 8 weeks at different combinations of temperature and humidity and monitored weekly for egg weight and Haugh Units to determine the effects of temperature and humidity on the "keeping power" of eggs.

In a separate study, samples of 90 eggs were obtained from a commercial grading facility, along with data from the commercial grader on the percentage cracks identified at the grading facility for the entire consignment of eggs from the same flock. The subsample of eggs was analysed for egg weight, shell reflectivity, shell breaking strength, shell deformation, shell weight and shell thickness. Percentage shell was calculated. These measurements allowed correlations to be made between the laboratory measurements of egg shell quality and the percentage cracks (and hence downgrades) identified at the commercial grading facility.

Results

Egg weight increased up until about 50 weeks of age and then remained relatively constant (Figure 1) whereas shell weight increased to 40 weeks and then remained constant (Figure 2).

Shell breaking strength declined with age (Figure 3) as did shell deformation (Figure 4). Shell reflectivity increased with hen age (Figure 5), indicating that shell colour became lighter. Although both egg weight and shell weight increased with age up to a point, the ratio of shell weight to egg weight, the percentage shell, decreased with age (Figure 6).

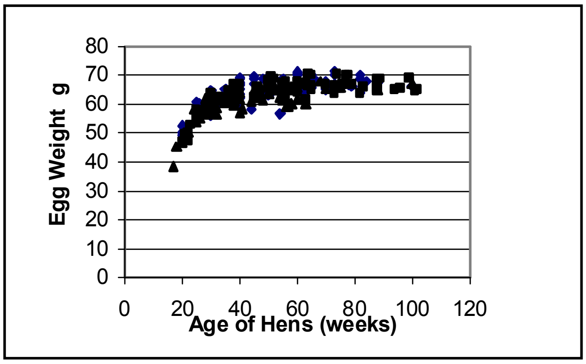

Figure 1 Egg weight vs hen age.

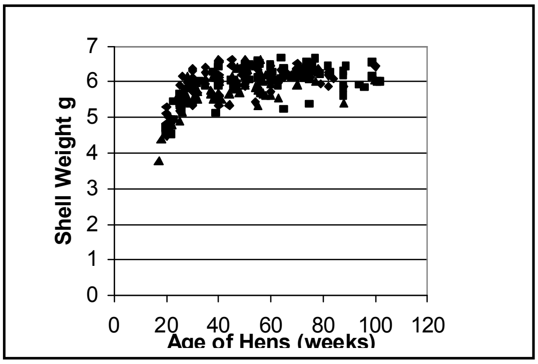

Figure 2 Shell weight vs hen age.

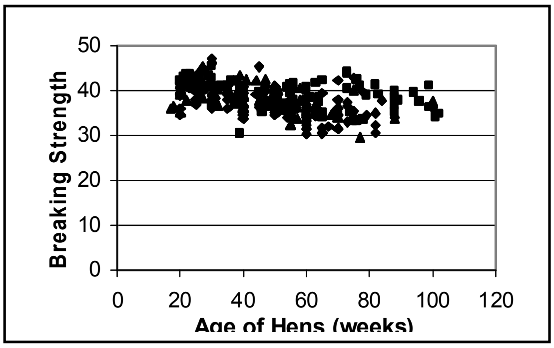

Figure 3 Shell breaking strength vs age.

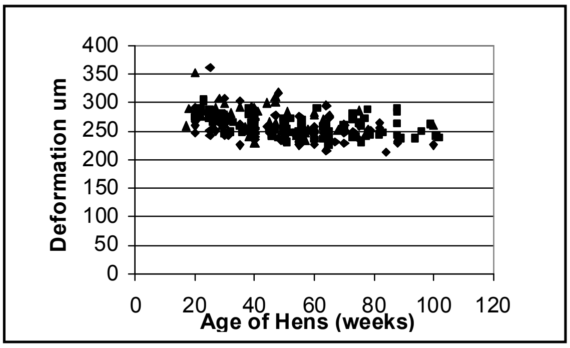

Figure 4 Shell deformation vs age.

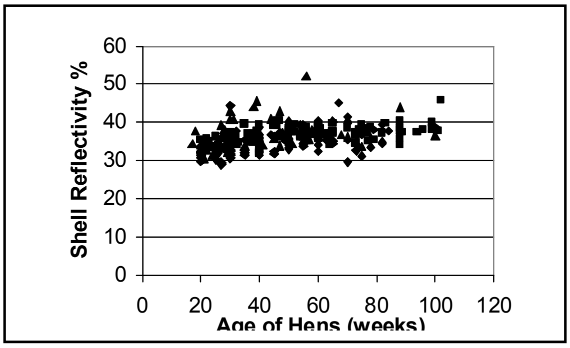

Figure 5 Shell reflectivity versus age.

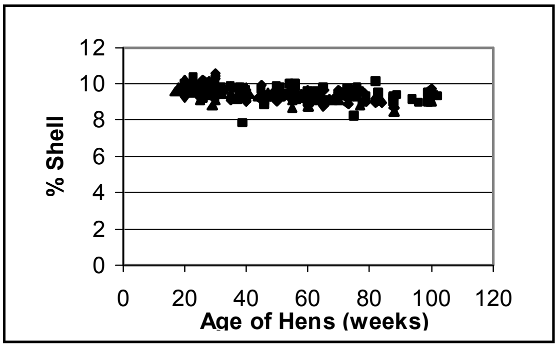

Figure 6 Percentage shell versus age.

Albumen height and Haugh Units calculated from albumen height and egg weight decreased with age of hen (Figure 7). However, the age of the egg itself (Figure 8) and the storage conditions affect albumen height and Haugh Units. Therefore, Haugh Units will be influenced by hen age, age of egg and storage conditions.

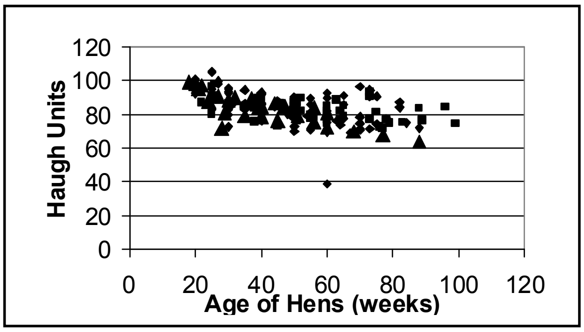

Figure 7 Haugh Units versus hen age.

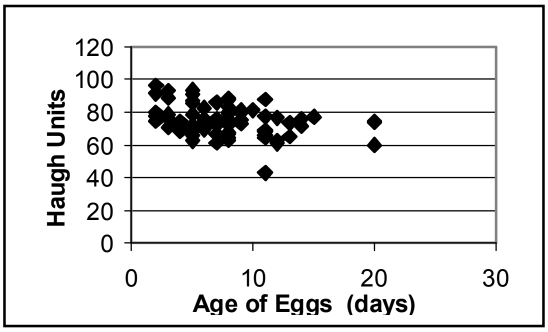

Figure 8 Haugh Units versus age of egg.

The effect of storage temperature on Haugh Units is illustrated in Figure 9. Weight loss in eggs stored at the same temperatures and relative humidities is shown in Figure 10. While storage temperature is the main determinant of Haugh Units, weight loss from the egg is significantly influenced by relative humidity.

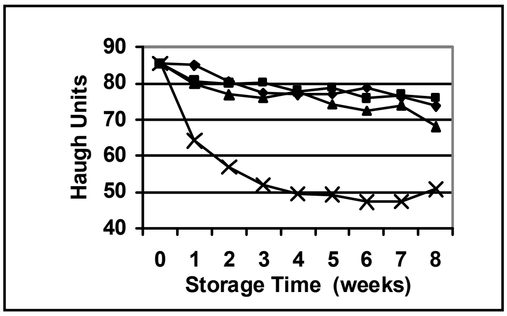

Figure 9 Haugh Units vs storage temperature.

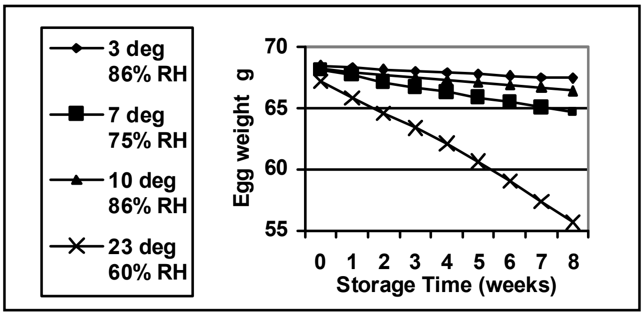

Figure 10 Egg weight vs temperature and relative humidity.

Figures 11-16 show the correlation between the percentage cracks identified at a commercial grading facility and the laboratory measurements of egg shell quality conducted at the University of New England on a subsample of eggs from the same batch.

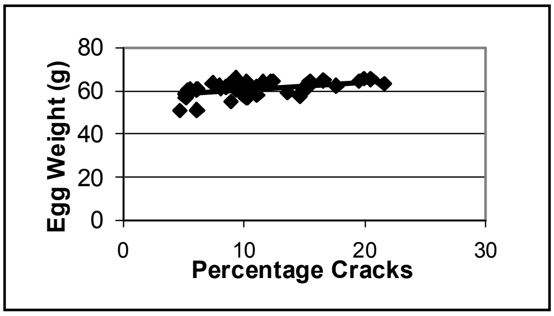

Figure 11 % cracks and egg weight.

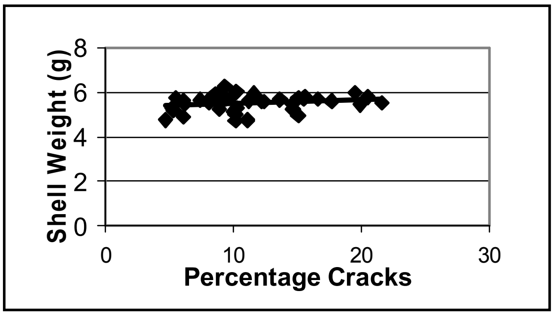

Figure 12 % cracks and shell weight.

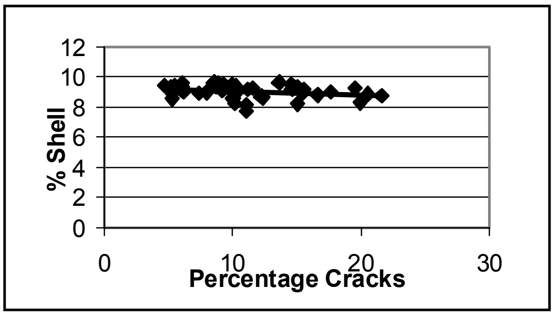

Figure 13 % cracks and % shell.

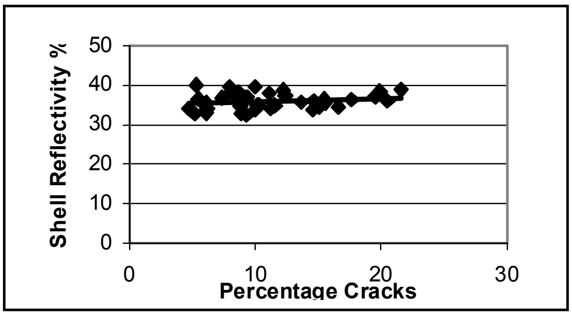

Figure 14 % cracks and shell reflectivity.

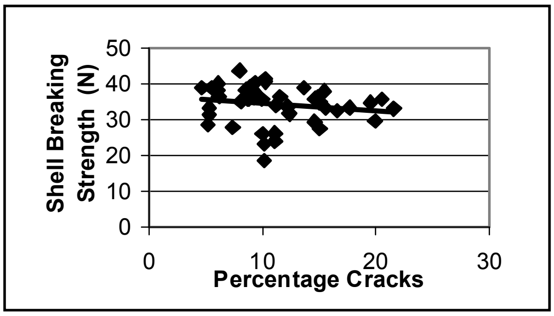

Figure 15 % cracks and shell strength.

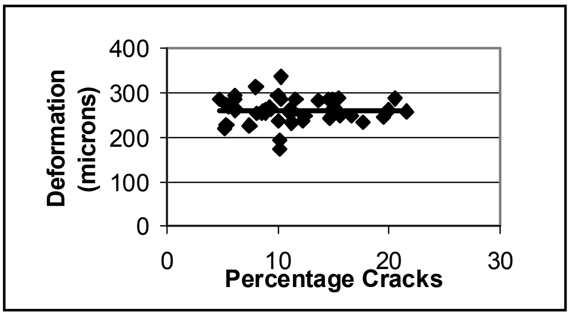

Figure 16 % cracks and deformation.

The percentage of cracks was higher for larger eggs (Figure 11) and for heavier shells (Figure 12). Cracks were also more likely in eggs with a lower percentage shell (Figure 13) and those with lighter coloured shells (higher shell reflectivity – Figure 14). A higher incidence of cracks was correlated with lower shell breaking strength (Figure 15) but there was little relationship between percentage cracks and deformation (Figure 16).

Discussion and conclusions

Considerable variation in the indicators of egg internal quality and egg shell quality exists within commercial flocks in Australia. Despite this variation, it is clear that there is an increase in egg weight and a decrease in egg shell quality (egg shell breaking strength, deformation, percentage shell) and internal quality (Haugh Units) as hens get older. Previous studies (Roberts, 1998, 1999; Roberts and Ball, 1998) have described the changes in egg internal quality and egg shell quality that occur as hens age in small commercial-style research flocks. They have also distinguished between Australian-bred and imported strains of bird. However, a systematic collection of such data from commercial flocks has not been attempted recently in Australia.

Scientific studies have investigated many of the factors that affect egg shell quality (see Wells and Belyavin, 1987). Factors which contribute to the variation reported from this study include: age of bird, strain of bird, climate, season of year, diet, rearing conditions, type of cage and housing.

Once eggs have been laid, they lose water by evaporation and albumen height decreases. The rate of weight loss of stored eggs is dependent on both temperature and humidity, with weight loss being greatest at higher temperature and lower humidity. However, as shown in the present study, albumen height and Haugh Units decline predominantly as the result of temperature and time, with humidity being less important.

Increased incidence of cracks identified at a commercial grading facility was correlated with increasing egg size but decreasing percentage shell, indicating that, although shell weight had increased also, this increase was not in proportion to egg weight. In addition, the incidence of cracks was positively correlated with lighter shell colour and lower shell breaking strength. Deformation remained relatively constant across the range of incidences of cracks recorded in this study.

This study will result in the publication of a practical booklet which will provide graphs of egg internal quality and egg shell quality for different strains of birds at different ages, under different conditions. In the booklet, the graphs will be presented as lines of best fit, along with the 95% confidence intervals, a format similar to that provided by breeder companies for body weight and production at different ages.

Acknowledgements

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