EYE LENS WEIGHT AND NITROGEN CONTENT PREDICT BEEF ANIMAL AGE[1]

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Introduction

With the emergence of Bovine spongiform encephalopathy (BSE) and the necessity to guarantee cattle ages to meet export requirements of some countries, the need to accurately determine age is paramount to the worldwide beef industry. The United States Department of Agriculture (USDA) estimates that only approximately 5% of U.S. beef cattle have documented chronological ages. Several methods for determining or predicting cattle age exist, including vertebra ossification, lean color, and dentition. Current systems can be criticized due to their subjectivity and subsequent inherent variability. Because concerns exist about current methods of determining cattle age, we investigated the use of the bovine eye lens to determine cattle age. Researchers have found that the eye lens grows continually throughout life, and that all animals exhibit a similar lens growth pattern. Lens properties, specifically weight and nitrogen content, are highly related to age of kangaroos, and are also minimally affected by diet and environment for swine. We hypothesized that eye lens weight and nitrogen content, alone or in combination, would more accurately predict the chronological age of cattle than dentition or carcass maturity.

Experimental Procedures

Eyes, dentition scores, and USDA overall maturity scores were obtained from cattle (n = 386) representing 15 feedyards in Kansas, Missouri, Nebraska, and Oklahoma, and were slaughtered at six different commercial beef processing plants. Fed steers, bullocks, heifers, heiferettes, and non-fed young cull cows, from 370 to 1,115 days of age, were used in this study. Eyes from a different group of 18 cows ranging from three to 12 years of age were collected to evaluate the lens as a predictor of age in much older cattle. For these 18 cows, a USDA grader was not present to determine overall maturity score. Data were supplemented with two randomly selected one- and two-year-old cattle from the larger group, for a total of 20 cattle, ranging from one to 12 years old.

Dentition was recorded immediately after slaughter; trained individuals were given a diagram and instructed to circle the image most similar to the mouth of the subject (Figure 1). If cattle had more than two sets of permanent incisors (indicating age of >30 months), data recorders documented the number of permanent incisors present. A USDA grader determined the USDA overall maturity score to the nearest 10 degrees at commercial-line speed. Overall maturity scores were transformed to numeric scores where A^{00} = 100, B^{00} = 200, and C^{00} = 300. The degree within each age range was added to the maturity range score. For example, A^{70} overall maturity was transformed to 170.

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Eyes were dissected and lenses removed, weighed, and stored at 35.6°F in an airtight container for nitrogen analysis. Total nitrogen was measured with a LECO Nitrogen Analyzer (Model FP-2000; LECO Corporation, St. Joseph, MI; AOAC Method 990.03) and converted to milligrams of nitrogen. In some cases, one viable lens remained, and thus only one lens was used to determine predictive ability. Statistical analyses were conducted to determine correlations with age, and to determine an age prediction equation.

Results and Discussion

Correlations for each independent age determinant and age in days for the slaughter-age group were: Lens weight (r = 0.77); dentition (r = 0.74); Lens nitrogen (r = 0.71); and USDA maturity (r = 0.64). Lens weight and age in years ($r^2 = 0.91$) and lens nitrogen content and age in years ($r^2 = 0.92$) were highly correlated in the cull group. Correlations obtained from the group of 20 cull cattle were clearly higher than those obtained from the group of 386 slaughter-age cattle. The slaughter-age cattle used in our study represented a very narrow age range (15 to 35 months) and, thus, the correlations of age predictors were somewhat lower. As indicated by the data including subjects of a much wider age range, however, both lens nitrogen and lens weight are good indicators of animal age.

From the larger slaughter-age group, an age prediction equation was developed (R^2=0.67): *Age (months)* = -21.79 + 17.23(*lens weight*) + 0.038(*dentition score*). To evaluate the application of this equation at the less than equal to 20-month threshold, the age prediction equation that we developed was used to predict ages of cattle up to 25 months old. The youngest and oldest ages predicted for cattle at each actual age in months (as determined by the equation) are listed in Table 1. The youngest age predicted with the equation using only lens weight and dentition score was 8.89 months, but the animal was actually 15 months old. The oldest age predicted was 30.47 months, but the animal was actually only 24 months old. No cattle greater than 20 months old had a predicted age less than 17.08 months. Among the 218 cattle less than or equal to 20 months old, 83 cattle, or 38.07%, had a predicted age less than 17.08 months (Table 1). The very young predicted ages for younger cattle are likely attributed to very young dentition scores (i.e., 100) because the equation includes dentition, but intermediate scores between 100 and 200 were not assessed. Figure 2 indicates the correct, grouping of cattle as less than or equal to 20 months old and greater than or equal to 20 months old. Those cattle in the shaded region of Figure 2 are correctly grouped by their predicted age as less than or equal to or greater than 20 months old. Those points in the non-shaded quadrants can be considered incorrectly grouped.

Table 1. The Youngest and Oldest Predicted Ages for 356 Slaughter Cattle Aged 25 Months or Less Using the Age Prediction Model

Actual Age (months)	Predicted Age	
	Youngest	Oldest
13	15.06	17.77
14	11.22	19.34
15	8.89	20.25
16	10.90	22.33
17	12.82	21.93
18	17.45	22.30
19	15.73	20.69
20	17.37	27.77
21	18.58	24.41
22	*17.08*	24.93
23	18.78	27.50
24	17.33	30.47
25	21.62	25.63

Implications

Lens recovery involves eye removal and dissection, as well as the use of an analytical balance. Eye removal can be accomplished at line-speed, but requires additional personnel for lens recovery. To successfully achieve the 20- versus 21-month age break, we recommend screening cattle based on dentition, because cattle without visible space between teeth (equivalent score of 100) were all less than or equal to 20 months old, and evaluating dentition is a very simple procedure. We do not recommend lens analysis for every beef animal to verify age. But this is a feasible procedure for pens or groups of cattle that are likely less than or equal to 20 months old, and a verifiable objective method is needed to document that cattle are less than or equal to 20 months.

With the re-establishment of overseas beef trade with some countries, use of the age-prediction equation developed in our study would effectively qualify nearly four times the number of cattle eligible for export trade than would currently qualify by using the USDA maturity limit.

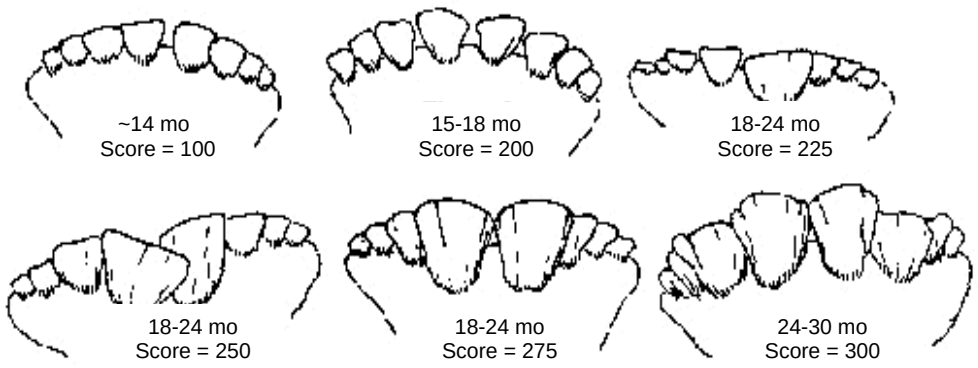

Figure 1. Changes in Dentition of Cattle Up to 30 Months of Age and Associated Numeric Dentition Score (adapted from Manitoba Agriculture, Food and Rural Initiatives).

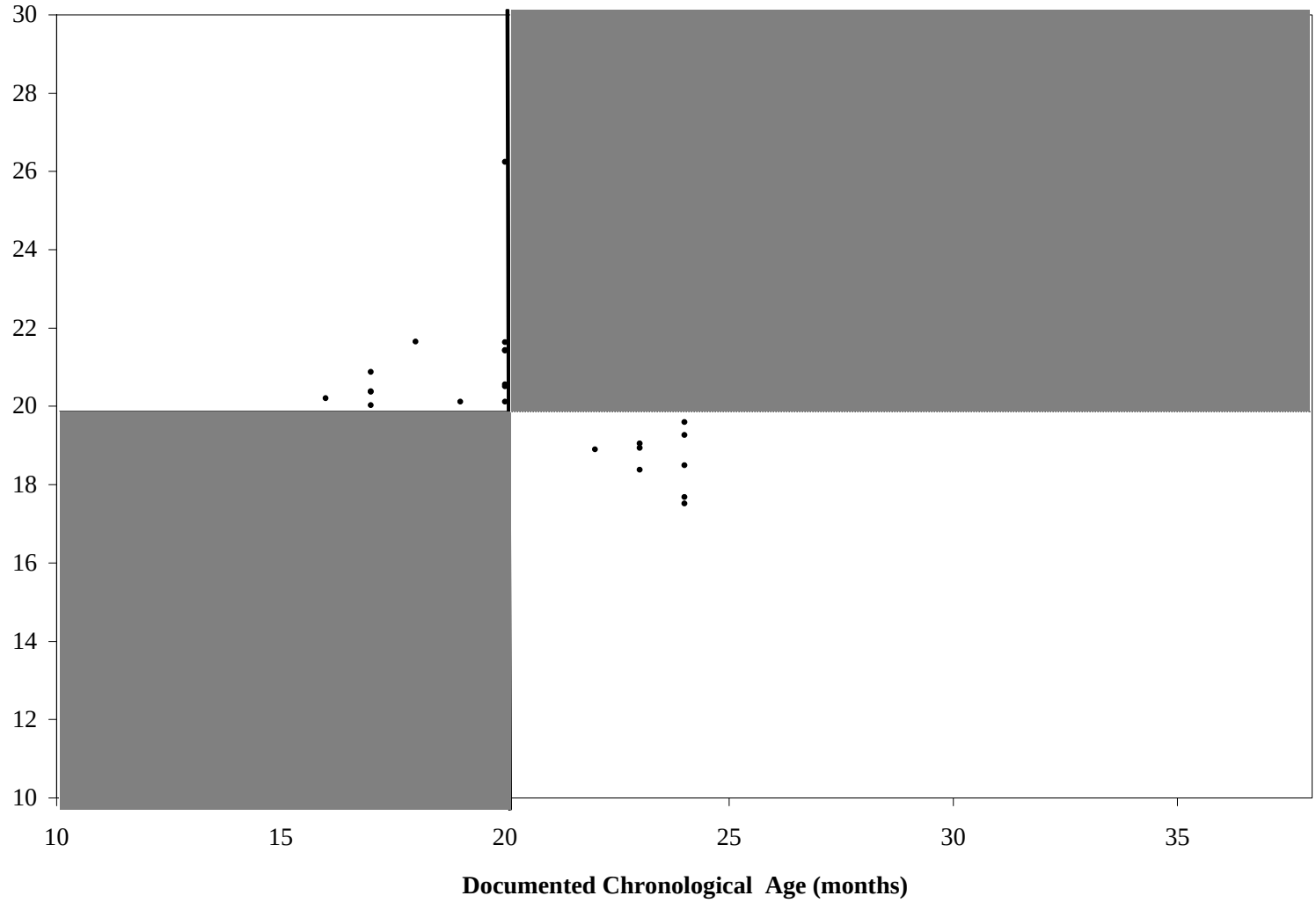

Figure 2. Documented Chronological Age versus Predicted Age at a 20-month Cut-off. Correctly grouped cattle are in the shaded quadrants.