Relationship between Ash Content of the Toe and Hardness of the Tibia Bone of Meat-type chicks

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It has been often claimed that the bone of modern broiler chicks was fragile and easily broken during the process of dressing. In this paper, relationship between hardness of the tibia bone and ash content of the toe of meat-type chicks of 6 and 8 weeks of age was reported, to study whether the hardness of the bone could be estimated from the toe ash content.

Materials and Methods

The toe and the tibia bone were obtained from chicks fed diets of various levels of calcium and available phosphorus in Expts. 606 and 609 reported in the previous paper1). In Expt. 606, 36 lots of 5 chicks each of either male or female chicks of 8 weeks of age were sacrificed, and the ash content of 5 left middle toes each as a group was determined as described in Official Methods of Analysis of the Association of Official Analytical Chemists2). From 5 chicks each, 2 chicks were selected at random and the hardness of their left tibia bone were determined individually by Kiya Hardness Tester 1600-D, which can estimate hardness less than 30 kg, as described by MEKADA et al.3) in detail. The hardness of the bone was given as kg of the pressure at which the bone was broken. Average of 2 estimates was taken as the hardness of the lot of 5 chicks.

In Expt. 609, 36 lots of 6 chicks each of either male or female chicks of 6 weeks of age were sacrificed. The ash content of 3 samples of left middle toes of 2 chicks each from each lot were determined, and average of 3 estimates was taken as the toe ash content of the lot of 6 chicks each. The hardness of the tibia bone of 3 chicks selected at random from each lot were determined individually, and average of 3 estimates was taken as the hardness of the lot. The hardness of 2 tibia bone from a male lot fed a diet containing the highest levels of calcium and available phosphorus in the experiment, i.e., 1.0% and 0.33%, respectively, was over 30 kg, so that exact hardness of the bones could not be determined. The value for the lot was missed.

From individual estimate of either the toe ash content or the tibia bone hardness in each experiment, variance of replication was calculated. The variance was multiplied by number of the chicks to get the variance corresponding to individual chick. Analysis of regression
on 71 pairs of the estimates of the toe ash content and the tibia bone hardness was carried out using an electronic computer ACOS 800 II of the Computing Center for Research in Agriculture, Forestry and Fishery with program written by one of the authors.

**Results and Discussion**

A linear relationship between the toe ash content and the tibia bone hardness of 71 pairs is presented in Fig. 1. Highly significant linear correlation (P<0.01) was observed, and the relation can be described by an equation given in Fig. 1. As observed in Fig. 1, deviation of individual estimates from the regression line was somewhat larger. The mean square of residual from regression was 12.3615 with degrees of freedom of 69. The square root of the residual was 3.515. The average of the tibia bone hardness in these experiments was 16.88 kg, so the coefficient of variation was 20.8%.

The standard deviation of the toe ash content of individual chick was 1.293. Average of the toe ash content in these experiments was 11.15%, so the coefficient of variation of toe ash content was 11.6%, which was comparable with that of body weight of the chick, i.e., 14%. The standard deviation of the tibia bone hardness of individual chick was 3.262, so the coefficient of variation was 19.3%, which was somewhat larger than that of the body.

![Fig. 1. Relationship between toe ash content and tibia bone hardness of meat-type chicks](image-url)
weight.

The large residual mean square from regression may indicate possible sex or age difference in the linear relationship, although these effects were neglected in Fig. 1. It should be pointed out that the maximum hardness measurable was 30 kg in these experiments, and that some of the bones had the hardness over 30 kg. Further accumulation of the data is required for further discussion.

The toe ash content, easily determined, is a good criterion of the bone hardness.

**Literature**