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A body condition scoring system for layer hens

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Abstract The body condition of end-of-lay hens was scored into four categories by palpating the keel and breast muscles. They were then killed with an overdose of pentobarbitone and physically dissected into fat, muscle, and bone. As the condition score increased, empty body weight, fat weight, muscle weight, and fat % in the empty body increased. Birds with the lowest condition score had particularly poorly developed breast muscles. This body condition scoring method can be a useful subjective way of assessing a bird's body reserves.

Keywords chicken; body condition score; body composition; fatness; emaciation

INTRODUCTION

Body condition scoring methods have been developed for horses, cows, sheep, and broilers (Frischknecht & Jull 1946; Henneke 1985; Orr et al. 1986; Edmonson et al. 1989). They are used for evaluating the adequacy of previous feed supply, determining future feed requirements, assessing the health status of individual animals, and establishing the condition of animals during routine animal management or welfare inspections. This paper describes a body condition scoring system for layer hens. It is based on palpating the breast and was developed in both white and brown breeds of bird. Previous work on grouse and pheasants has suggested that breast muscle development may be a useful indicator of protein mobilisation for egg production and subsequent muscle atrophy (Reynolds 1997). In the present study, body condition was evaluated in terms of the estimated muscle and fat weights in the physically dissected body.

MATERIALS AND METHODS

The body condition of 184 end-of-lay Shaver Brown 579 and Shaver White 2000 caged layers was scored by one person in the following manner. The live birds were held individually by both legs in one hand and with the head downwards. The palm of the other hand was used for palpating and grading the protruberance of the keel, the development of the breast muscles immediately alongside the ventral ridge of the keel, and the convexity or concavity of the breast muscle contour. Body condition was scored in this way on a 0–3-point scale. 0 corresponded to a prominent ridge on the keel with limited overall breast muscle and concavity of the breast muscle alongside the keel, 1 had greater development of breast muscle which was not concave and was usually flat in contour, 2 had a moderately developed convex breast muscle, and 3 was a well developed relatively plump breast. In some birds there was obvious asymmetry in the breast muscles, with the left breast appearing to be larger than the right breast. In this situation an average score was given, and extreme cases of asymmetry were purposefully not selected for dissection. Brown and white breeds were selected for the study with a view to developing a method which could be applied to both types. There were 10 birds (5 brown and 5 white) for each body condition score, and they were between 72 and 85 weeks of age. It had been intended to select 40 birds for dissection from one farm but only 38 came from the farm where body condition had been scored in the 184 birds. Two brown breed birds were therefore obtained from a separate farm.

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The birds were given a conventional chicken mash up to the time they were killed with an overdose of intravenous pentobarbitone (about 2 ml of 120 mg ml^{-1} via the wing vein). Carcasses were dissected and the main body parts weighed. Blood was not voided and was allowed to clot within the carcass. The procedures used during the dissection were as follows. Breast muscle contour was measured by pressing and moulding a piece of wire (plastic-coated copper wire with an outer diameter of 3 mm) against the contour of each breast from the midpoint along the length of the keel. The area beneath 9.5 cm of the arc formed by the piece of wire was traced onto paper and measured by planimetry for each side of the breast.

The sequence of the dissection and weighing schedule for the different body parts was as follows: feet with shanks, head, pygostyle including skin, wingtips including feathers, skin and feathers, subcutaneous fat with adhering connective tissue, oyster muscles, legs, wings, furculum, breast muscles, coracoids, scapulas, sternum, muscle around the coracoids, scapulas and ribs, abdominal wall muscles, liver, ovary, spleen, heart, trachea and lungs, urinogenital tract, alimentary tract full and empty, intra-abdominal fat, kidneys, remaining skeletal muscle on the torso, torso bone, and neck. Empty body weight was calculated by adding together the weights of all the body parts after gut contents had been removed by hand. The weight of muscle was assessed by weighing the dissected muscle from the limbs and torso, and in the case of the neck by assessing the difference in the weight of the neck after it had been boiled in water and the soft tissues removed. Fat weight included intra-abdominal, subcutaneous, and intermuscular fat but did not include the fat which was firmly attached to the inner surface of the skin and could not be removed easily with a knife. The head, shank, feet, skin, wingtips, and pygostyle were not dissected into their component tissues, and so the estimates for bone, muscle, and fat weight did not include tissue weights from those parts. Statistical analysis was performed by linear regression and Student *t*-test (Snedecor & Cochran 1980).

RESULTS

Representative examples of each body condition score are shown in Fig. 1. These diagrams have been standardised to an equal body cavity width and height so that they are not confounded visually by differences in size of the skeletal frame. Of the 184 birds that were condition scored at the first farm, 7, 56, 35, and 2% had condition scores 0, 1, 2, and 3, respectively.

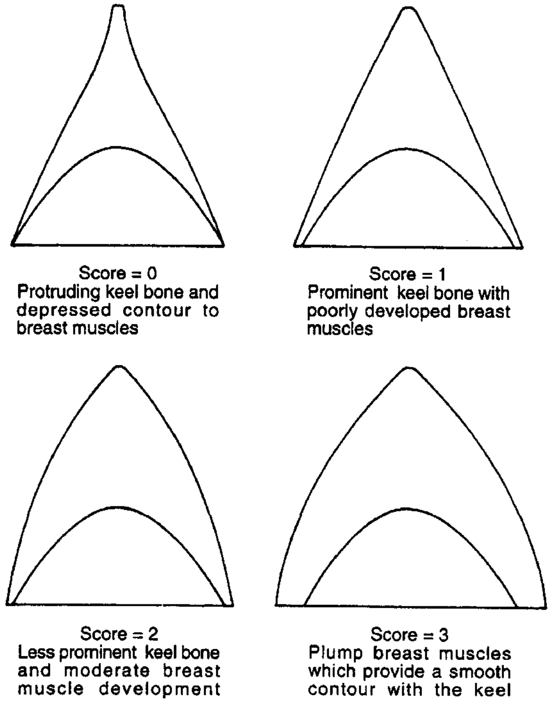

Fig. 1 Diagramatic cross-sections of the breast muscles and ventral abdominal cavity for the 4 body condition scores. Each score has been standardised to the same body cavity dimensions.

The mean liveweight of the birds was 2.00 kg (±0.06 s.e., range 1.28–2.62 kg). Empty body weight increased with increasing body condition score, and on average the birds with a body condition score of 3 were over 50% heavier than the birds scoring 0. Mean bone weight was the same in the four condition scores, suggesting that overall skeletal size was similar in all four scores (Table 1). However, muscle and fat weight increased with increasing body condition score. About 77% of the difference in empty body weight between the condition score 3 and 0 birds resulted from differences in muscle and fat weight. Differences in absolute fatness accounted for most of that difference, and this was evident when the results were expressed as proportions of fat in the empty body.

The overall range in dissectible fat weight was 4–644 g. Two birds with 0 condition score had virtually no dissectible body fat (<10 g). However, absence of dissectible fat would not be a characteristic and distinguishing feature for this score. For example, two of the 0 score birds had >170 g dissectible fat. Other measures appeared to discriminate more clearly the 0 condition score from the other scores. Three of these were the breast muscle to total bone ratio, the leg muscle to breast muscle ratio, and the breast muscle contour (Table 1). All of these measures showed that the breast muscle was poorly developed in the 0 condition score birds. This result helped to support the accuracy of manual palpation of the breast as a guide to breast muscle development. Although the leg muscle:breast muscle ratio was high in the 0 score birds, muscle atrophy may not have been specific to the breast muscle as the leg muscle:total bone ratio was also depressed in these birds.

Asymmetry between the breasts made condition scoring difficult in some birds. Of the dissected birds, 36 (90%) had a heavier left breast. On average the left breast muscles were 2.7 g (±0.8) heavier than the right breast muscles and the left breast muscle contour was 19% greater.

In general, there were few differences between the white and brown hens. They had comparable empty body weights (white 1.945 kg ± 0.086 cf. brown 1.921 kg ± 0.070) and overall composition, but they did differ in the distribution of their body fat. In the 30 birds with body condition score ≥1, the white birds had a higher subcutaneous fat:intra-abdominal fat ratio than the brown birds (0.78 ± 0.04 cf. 0.58 ± 0.04, $P < 0.01$). This ratio was not strongly influenced by overall fatness. For example, it was estimated using linear regression analysis that a 100 g increase in body fatness would result in only a 0.0396 increase in the subcutaneous fat:intra-abdominal fat ratio ($y = 0.5402 + 0.000396x$; where y is subcutaneous fat:intra-abdominal fat ratio and x is total body fat; $P < 0.05$).

DISCUSSION

When hens are underfed relative to their level of egg production, they are likely to undergo proteolysis of liver and muscle, lipolysis in adipose tissue, and resorption of bone. Similarly, when hens are genetically selected for increased egg production, it would be expected that they would become smaller, with less body fat but larger livers (Doornenbal et al. 1970; Frankham & Doornenbal 1970). On this basis it might be expected that the weight of fat, muscle, and possibly bone would be decreased and that liver weight may also be affected in birds which become emaciated by the end of lay. This study indicated that depletion of body reserves in end-of-lay birds was in fact greatest for body fat and muscle, but it was not evident from the weights of liver or bone. Some birds had virtually no dissectible body fat.

This study also showed that grading live hens on a four point scale according to the protruberance of the keel and size of the breast muscles can be effective in distinguishing total fatness, proportionate fatness, and total muscularity in the birds' bodies. Increasing condition score was associated

Table 1 *Body composition according to body condition score in hens, means ± s.e. § excludes weight of bones in the head, wingtips, shank, feet, and pygostyle; ¶ % of empty body weight. Rows with different letters were significantly different $P = 0.05$.*

	Body Condition Score			
	0	1	2	3
Number of chickens	10	10	10	10
Empty body weight kg	1.492 ± 0.063a	1.849 ± 0.061b	2.131 ± 0.064c	2.259 ± 0.048c
Bone g §	224 ± 9	229 ± 6	239 ± 7	239 ± 12
Muscle g	565 ± 30a	680 ± 18b	724 ± 20bc	751 ± 25c
Fat g	86 ± 20 a	221 ± 30b	361 ± 36c	487 ± 32d
Liver g	54 ± 4	58 ± 3	55 ± 4	61 ± 8
Bone % §¶	15.1 ± 0.4a	12.4 ± 0.3b	11.0 ± 0.2c	10.6 ± 0.4c
Muscle % ¶	37.8 ± 1.0a	36.9 ± 0.7a	34.2 ± 0.7b	33.3 ± 0.9b
Fat % ¶	5.5 ± 1.2a	11.5 ± 1.3b	16.9 ± 1.4c	21.5 ± 1.2d
Liver % ¶	3.7 ± 0.3a	3.2 ± 0.2ac	2.6 ± 0.2b	2.7 ± 0.3bc
Breast muscle:bone	0.721 ± 0.041a	0.937 ± 0.032b	1.005 ± 0.026b	1.023 ± 0.038b
Leg muscle:bone	1.028 ± 0.039a	1.184 ± 0.027b	1.173 ± 0.057b	1.234 ± 0.028b
Leg muscle:breast muscle	1.452 ± 0.053a	1.274 ± 0.033b	1.228 ± 0.028b	1.213 ± 0.25b
Breast muscle contour cm^2	9.1 ± 0.6a	11.9 ± 0.7b	12.3 ± 1.0b	13.1 ± 0.7b

with increasing fatness and muscularity. Birds which had the lowest condition score were emaciated and were distinguished by a low breast muscle:bone ratio and a low breast muscle:leg muscle ratio. The condition scoring itself was a relatively easy procedure, taking about 15 s per hen. The only complication was asymmetry between the breast muscles in some birds.

The relationships between body conformation or condition and body composition have not been examined previously in hens. It has been suggested that skinfold thickness of the abdominal wall might be a useful estimator of condition (Greenberg 1976), but it has not been systematically evaluated. Fleshing scores and plumpness of the breast have been used in broilers (Frischknecht & Jull 1946; Dawson et al. 1957). For example, Frischknecht & Jull (1946) used a four point scale for grading live 12-week-old broilers (excluding emaciated birds) according to the breadth of their breast and muscularity of the breast and legs. Their system gave good discrimination for cross-sectional area of the breast muscle, width of the breast, weight of the breast muscle, and bird live weight. Bird (1943) noted that in broilers the plumpness of the breast muscle may be influenced by the length of the keel. An unusually long keel may detract from the round appearance of a breast whereas a very short keel may enhance plumpness. In the present study, such differences in skeletal size were partly accounted for by examining the ratio of breast muscle weight to bone weight. In terms of this index the condition scoring method was still useful in distinguishing the emaciated bird with poor breast conformation. This is consistent with work in broilers which has reported that breast muscle weight was more closely related to thickness of the breast muscle than to either breast muscle length or breast muscle width (Herstad & Frisch 1972; Lubritz 1997).

Wilson (1954) found that Rhode Island Red cockerels which put on weight fastest deposited the additional fat in the subcutaneous region rather than inside the abdomen. There was no strong relationship between total fatness and the ratio of subcutaneous to intra-abdominal fat in the hens in the present study, but there was a clear breed difference. The white layer breed deposited more fat subcutaneously than the brown layer breed. Mahadevan & Bose (1951) found that the weight of leg muscle was greater in Rhode Island Red cockerels than White Leghorns, whereas breast muscle development was similar. In this study, the ratio of leg muscle weight to breast muscle weight was the same in the brown and white breeds.

One of the main reasons for undertaking this study was to develop a simple and quick method for assessing the status of birds which allegedly were emaciated through mis-management. In this respect the method was found to be helpful in assessing the likelihood of emaciation and it could avoid the need for killing birds and performing postmortems. This method could have other uses, and it would complement the measurement of liveweight in routine management and research assessments. The potential advantage of body condition scoring in comparison with measuring liveweight is that it assesses condition relative to skeletal size and so it is less likely to be confounded by innate differences in mature body size. In its present form, however, it does not give fine discrimination between individual birds.

Thus, this study has produced a body condition scoring system for hens which provides good relationships with a bird's fat and muscle reserves.

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