ESTIMATING CARCASS FAT LEVELS IN RUFFED GROUSE FROM WING FAT

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Abstract: A technique for estimation of carcass fat levels in ruffed grouse (*Bonasa umbellus*) from wing fat levels is evaluated. The utility of this technique was investigated because many state wildlife agencies annually collect grouse wings for purposes of age determination and hence wings are readily available. Mean wing fat (percent ether extract) levels were not significantly different than carcass fat levels in grouse collected in fall and winter. Significant differences were found between wing and carcass fat levels in spring ($P < 0.10$) and summer ($P < 0.01$) collected birds. Despite these differences, wing fat data from spring collected birds may be useful for prediction of carcass fat because of a high correlation coefficient ($r = 0.82$) between the two variables. A lower correlation coefficient ($r = 0.68$) indicated limited utility for this technique in summer. No significant differences in wing fat levels were found between air-dried and frozen wing samples. Recommendations regarding wing sample size are discussed.

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Physiological indices have been useful in understanding the nutritional ecology of wildlife populations, since they provide insight into the ecological relationships between an organism and its environment (Kirkpatrick 1980). Application of indices of nutritional states in avian populations usually involves analysis of body fat levels (Odum and Connell 1956, West and Meng 1968, Braun 1971, Robel 1972, Pendergast and Boag 1973, Ijas et al. 1976, and Dabney and Dimmick 1977). In evaluating the merits of several condition indices of bobwhite quail (*Colinus virginianus*), Dabney and Dimmick (1977) advocated a combination of indices to achieve a complete assessment of population condition. Total body fat was recommended as the best single indicator.

Our objective was to evaluate a technique for estimating carcass fat levels in ruffed grouse from wing fat content. Many state agencies annually collect wings from hunter-killed ruffed grouse for purposes of age determination to monitor population structures. In addition, the effects of air drying on wing fat levels were evaluated because precautions to prevent desiccation usually are not taken in wing collection programs.

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METHODS

Carcass and Wing Necropsy

Thirty-four ruffed grouse were collected by shooting or picked up as road kills in southwestern Virginia during the 4 seasons of the year. Grouse were frozen in plastic bags until necropsy. The carcass was allowed to thaw and all feathers were removed. The head was removed at the base of the skull and the legs were severed at the tibiotarsus-tarsometatarus junction. The wings were removed by first cutting the skin at the surface where the wing attaches to the carcass (total wing, Fig. 1), following the outline of the wing muscles. Care was taken not to cut surrounding fat layers adjacent the crop. The wing was then cut into pieces and refrozen. The samples analyzed included the skin, all muscles with tendinous origins on the humerus and more distal bones, wing muscles with origins in the scapulo-coracohumeral joint, and the humerus and more distal bones (Norman 1980:120).

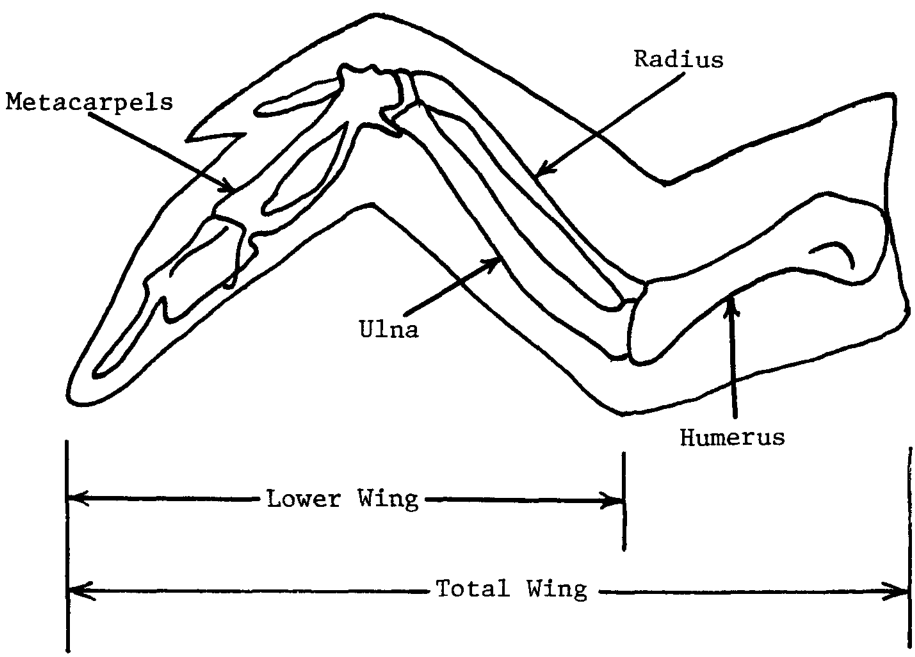

Fig. 1. Diagram showing parts of wing used in the various experiments.

Major organs and the digestive system were removed from the body cavity and excluded from fat analysis. Mesentary fat was separated from the intestines and ceca and returned to the body cavity. The carcass was cut into pieces and refrozen. Frozen carcasses were then processed through a meat grinder and lyophilized for approximately 96 hours. Wings were lyophilized for approximately 48 hours. After drying, the carcasses and wings were separately ground in a Waring blender an analyzed for crude fat (percent ether extract) in a Soxhlet apparatus using diethyl ether (Warren and Kirkpatrick 1978). Carcass and wing fat content means were tested for difference by a paired T-test procedure. Data for the carcass and wing fat content were also analyzed for correlation using the Pearson product moment procedure.

Effects of Air-Drying on Wing Fat Content

Ten pairs of wings from recently killed (<48 hours) birds donated by hunters were used to test the effects of air-drying on wing fat content. The wings received were cut at various places along the humerus by hunters. The section of the wing to be analyzed was therefore standarized by removing the remaining sections of the humerus, using only the radius, ulna, and more distal sections of the wing (lower wing, Fig. 1).

One wing of each individual was frozen for approximately 70 days and the second was allowed to air-dry in a manila envelope for the same period. Feathers were then removed and wings were lyophilized and ground in a Waring blender. Processed wings were analyzed for crude fat as described above. Means were compared using a paired T-test procedure.

RESULTS AND DISCUSSION

Mean wing fat content was not significantly different than mean carcass fat content in grouse collected in fall and winter. However, spring and summer collected birds had higher fat levels in wings than in carcasses ($P < 0.10$ and $P < 0.01$, respectively). Despite these differences, wing fat data may be useful in estimating carcass levels in the spring because the 2 variables were strongly correlated ($r = 0.82$, Table 1). A lower correlation coefficent ($r = 0.68$) indicated the utility of this technique may be limited in the summer season when fat levels are lowest.

Mean fat content (± standard error) of the air-dried and frozen wings was 20.1 ± 1.1 and 19.0 ± 1.2 g, respectively. Differences in fat content between air-dried and frozen wings were not significant.

Fat levels in different sections of the wing appear to vary. Wings analyzed in the air-drying experiment were cut at the humerus/radius-ulna junction (lower wing, Fig. 1), because hunters who donated these wings cut them at various points along the humerus. The humerus section was included in the wing analysis in the previous experiment in testing differences between carcass and wing fat levels. Fat levels in lower wing samples from ruffed grouse killed in winter were greater ($\overline{X} = 19.0 \pm 1.2$) than those in total wing samples ($\overline{X} = 16.6 \pm 0.9$). Lower fat levels in the total wing sample may be the result of a greater proportion of muscle in the humerus section of the wing. Despite this difference, standardization of the wing sample for analysis will eliminate any potential bias of the percentage of fat in the sample from differing muscle masses.

The order of fat catabolism in grouse appeared to be different from that reported for deer (Harris 1945, Riney 1955). While these workers reported that subcutaneous fat is used before abdominal fat in deer, the relatively higher percent

Table 1. Carcass fat content (percent dry carcass wt.), total wing fat content (percent dry wing wt.), and correlation coefficents between carcass and wing fat content for ruffed grouse collected between March 1979 and January 1980 in southwestern Virginia. Number of birds is in parenthesis.

Season	Carcass fat ($\bar{X} \pm SE$)		Wing fat ($\bar{X} \pm SE$)		Correlation coefficients (*r*)
Summer (7)	4.3	0.1	8.7	1.4	0.68*
Fall (8)	12.9	1.3	14.1	0.4	0.89**
Winter (10)	16.4	1.6	16.6	0.9	0.86**
Spring (9)	5.3	0.3	12.4	1.3	0.82**

* $P < 0.05$
** $P < 0.01$

of fat of wings in the spring and summer killed grouse indicates that abdominal fat may be used more rapidly than subcutaneous fat in times of energy deficit in this species.

Fat levels appear to be a function of digestible energy intake. Norman (1980) found increased fat deposition in the fall and winter seasons when ruffed grouse feed on highly digestible diets of hard and soft fruits. Fat utilization during the spring and summer seasons was postulated to be the result of energetic requirements exceeding that supplied by lower quality diets of woody and nonwoody leaves.

As previously mentioned, many state wildlife agencies annually collect wing samples from hunters. The collection of numerous wings from different areas throughout the season for fat analysis is therefore possible. Field collection of ruffed grouse carcasses in similar circumstances on an annual basis to monitor nutritional status would be cost prohibitive. It is believed that wing fat analysis may greatly assist biologists in identifying the role nutrition plays in ruffed grouse population regulation. In addition, techniques for determination of crude fat outlined by Harris (1970:2301), Cullison (175:16), and Warren and Kirkpatrick (1978) are relatively simple procedures that may be conducted in most laboratories or contracted to a university or research group (Kirkpatrick 1980:106).

LITERATURE CITED

Braun, C. E. 1971. Seasonal trends in body fat of white-tailed ptarmigan. Bull. Soc. Am. 52:44.

Cullison, A. 1975. Feeds and feeding. Reston Publ. Co. Inc., Reston, Va. 486pp.

Dabney, J. M., and R. W. Dimmick. 1977. Evaluating physiological condition of bobwhite quail. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies. 31:116-122.

Harris, D. 1945. Symptoms of malnutrition in deer. J. Wildl. Manage. 9L319-322.

Harris, L. E. 1970. Nutrition research techniques for domestic and wild animals, Vol. I, An international record system and procedures for anlayzing samples. Utah State Univ., Logan. 233pp.

Ijas, L., I. Nuuja, R. Palokangas, J. Soimajarvi, and P. Valkeajarvi. 1976. Body lipid composition in the winter fed and control populations of the wild male black grouse in autumn and spring. Comp. Biochem. Physiol. 60:313-317.

Kirkpatrick, R. L. 1980. Pages 99-113 *in* S. Schemnitz, ed. Wildlife management techniques manual, 4th ed., The Wildl. Soc., Washington, D.C.

Norman, G. W. 1980. Nutritional ecology of ruffed grouse in Southwest Virginia. M. S. Thesis, Va. Polytechnic Inst. and State Univ., Blacksburg. 135pp.

Odum, E. P., and C. E. Connel. 1956. Lipid levels in migrating birds. Science. 123:892-894.

Pendergast, B. A., and D. A. Boag. 1973. Seasonal changes in the internal anatomy of spruce grouse in Alberta. Auk. 90:307-317.

Riney, T. 1955. Evaluating condition of free-ranging red deer (*Cervus elaphus*) with special reference to New Zealand. New Zealand J. Sci. Tech. 36:429-463.

Robel, R. J. 1972. Body fat content of bobwhites in relation to food plantings in Kansas. Pages 139-149 *in* J. A. Morrison and J. C. Lewis, eds. Proceedings First National Bobwhite Quail Symposium. Okla. State Univ., Stillwater. 394pp. (Cited by Dabney and Dimmick (1977); not seen).

Warren, R. J., and R. L. Kirkpatrick. 1978. Indices of nutritional status in cottontail rabbits fed controlled diets. J. Wildl. Manage. 42:154-158.

West, G. C., and M. S. Meng. 1968. Seasonal changes in body weight and fat and the relation of fatty acid composition to diet in the willow ptarmigan. Wilson Bull. 80:426-441.