FAT IN THE MANDIBULAR CAVITY AS AN INDICATOR OF CONDITION IN DEER[1]

by
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ABSTRACT

Fat from the marrow tissue of the femur (FMT) of white-tailed deer (*Odocoileus virginianus*) was found to be a poor standard with which to verify that the fat in the tissue of the mandibular cavity (MCT) was an indicator of condition. Fat from the tissue of the mandibular cavity (MCT) was found to separate into more distinguishable condition classes than was fat from the femur marrow tissue (FMT). MCT fat appeared to be utilized prior to the utilization of FMT fat. Percent MCT fat was found to vary between the right and left mandibles of the same animal. Animals 2.5 years or older had much less variation between the MCT fat levels of the right and left mandible than did animals 1.5 years or less. Fat from the tissue of the mandibular cavity was shown to be a fat reserve and it is therefore postulated that this reserve can be used as an indicator of condition, provided MCT fat's position in the fat utilization and replacement order is known, and provided that MCT fat is not completely utilized or replaced by an animal.

INTRODUCTION

Nichols and Pelton (1972) reviewed the use of fat as an index to condition in various hooved mammals. However, other than the recent work of Verme and Holland (1973), little has appeared in the literature regarding the verification of the accuracy of any specific technique for determining fat levels. The present study is a preliminary attempt to evaluate in more detail the use of fat of the mandibular cavity as an index to condition in white-tailed deer (*Odocoileus virginianus*).

Collections of mandibles from white-tailed deer were made on six wildlife management areas (WMA) in Tennessee (Nichols and Pelton 1972). Each WMA is located in a different physiographic region (Dickson 1960, Rand 1970). The areas where collections were made include the Tellico, Chuck Swan, Catoosa, Cheatham, Natchez Trace, and Shelby WMA's. Collections were made during the 1969-1970 and 1970-1971 hunting seasons on the Chuck Swan WMA, and on all WMA's during the 1970-1971 hunting season.

MATERIALS AND METHODS

Deer Femur/Mandible Combinations

Collection of deer femur/mandible combinations was initiated during the 1969-1970 hunting season on the Chuck Swan Wildlife Management Area, Union County, Tennessee. Collecting continued during the 1970-1971 and 1971-1972 hunting seasons for this area. Femur/mandible combinations taken on WMA's were removed from only those animals that were confiscated, illegal kills, or those animals found shot and located by the hunter. Deer were categorized into general condition classes based on work by Harris (1949).

Other femur/mandible combinations were collected throughout the state on a year-round basis from deer accidently killed. These collections began in December, 1969, and continued until December, 1971. All femur/mandible combinations were tagged, placed in double plastic bags, and frozen until time for analysis.

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Deer Mandible Collections

Collections of mandibles from the Chuck Swan WMA were begun during the 1969-1970 hunting season. During the 1970-1971 hunting season, mandibles were collected from all six management areas.

Femur and Mandible Analysis

Mandibles were stored at a temperature of 0° C. or less until time for analysis. Upon removal from the freezer, all excess tissue was removed. Fat from the femurs and mandibles was extracted according to the methods of Nichols and Pelton (1972).

Data concerning the femur and mandible comparisons were analyzed on a Wang Advanced Programming Calculator. The statistical procedure included the determination of means and/or linear regressions between percent FMT (femur marrow tissue) fat or MCT (mandibular cavity tissue) fat and age, weight, date of collection and general condition.

Special Mandible Analysis

In addition to analyzing femur/mandible combinations and single mandibles, where possible, fat levels of the left and right mandibles of the same animal were compared. Also, seven mandibles were sectioned into five pieces to determine if there were any variations in fat levels within separate sections of the MCT cavity of one mandible. Method of laboratory analysis of fat of left and right paired mandibles and sections of individual mandibles was the same as for the mandible analysis previously mentioned.

Standardized sections for the seven mandibles were produced in the manner illustrated in Figure 1.

The statistical procedure for analysis of left/right mandible comparisons and sectioned mandibles involved the determination of means and paired t-tests.

RESULTS AND DISCUSSION

Analysis of Femur/Mandible Combinations

A total of 68 femurs and mandibles from 59 animals was analyzed. If two femurs and two lower mandibles were collected from an animal, these were considered as two separate samples for femur fat and mandible fat comparisons. An average of the levels of the fat in the FMT and MCT for each individual was used for comparison with age, weight, sex, date of collection and general condition.

A summary of the correlation coefficients (r) for all femur/mandible combinations collected and subsequently analyzed is presented in Table 1. The highest correlation coefficient was $r=0.69$ (significant at $P<0.05$), the correlation coefficient for the femur marrow tissue, mandibular cavity tissue relationship. Other significant correlations ($P<0.25$) included age/weight ($R=0.56$), general condition/weight ($r=0.49$), general condition/date collected ($r=0.47$), MCT/weight ($r=0.50$) and MCT/age ($r=0.29$).

On 20 animals, from which femurs and mandibles were collected, the general condition of the animals was determined visually by estimation of the amount of body fat present. In this sample, the FMT/MCT relationship had a correlation of $r=0.86$. In addition, MCT was significantly correlated to age ($r=0.46$) and weight ($r=0.50$). Other correlation coefficients for animals of known condition are shown in Table 2. The mean percent FMT fat for those animals of known condition was 77.0 percent for those animals placed in the poor condition class (Class 1), 90.5 percent for those animals in fair to good condition (Class 2-3), and 97.7 percent for those animals in excellent condition (Class 4). The corresponding means for MCT fat were 63.4, 78.6, and 92.4 percent, respectively (Table 3).

In their work on the fat from the tissue of the mandibular cavity, Baker and Leuth (1966) noted that MCT fat was related to physical condition in deer. They concluded that this relationship was valid since age, weight and date of collection were more highly correlated with MCT fat than with FMT fat. In the present work, significant correlations were found between MCT/weight and MCT/age. The correlations of

FMT and these latter variables were not significant. The fat from the tissue of the mandibular cavity and femur were not significantly correlated ($P \leq 0.05$) with general condition ($r=0.41$). However, at the 90 percent confidence level MCT fat was significantly related to general condition whereas fat of the FMT was not ($r=0.35$).

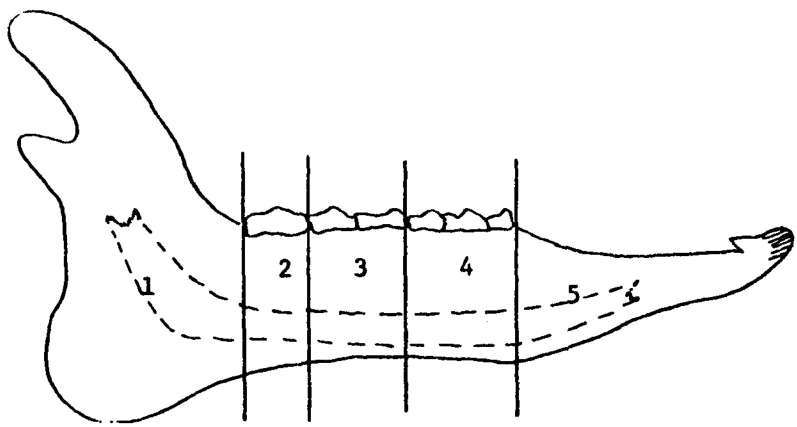

Figure 1. Standardized sections of mandible for comparing fat levels throughout the MCT cavity. Dotted lines(---) indicate approximate position of the mandibular cavity tissue. Samples consist of the MCT between the solid vertical lines( ). Numbers indicate the section number.

Table 1. Correlation coefficients of each of six variables with each of the other variables for femur/mandible combinations of white-tailed deer.

	Femur marrow tissue fat	Age	Weight	General condition	Date
Age	0.063 (51)a				
Weight	0.217 (44)	0.557b (44)			
General condition	0.346 (22)	0.306 (20)	0.494b (18)		
Date	0.049 (51)		0.166 (44)	0.468b (20)	
MCT fatc	0.693 (68)	0.288 (51)	0.498 (44)	0.413 (20)	0.065 (51)

(a)Number in parentheses represents the sample size for the correlation.
(b)Correlation coefficient significant at P - 0.05.
(c) Tissue fat of the mandibular cavity.

Table 2. Correlation coefficients of each of four variables with each of the other variables for femur/mandible of white-tailed deer of known condition.

	Femur marrow tissue fat	Age	Weight
Age	0.230 (20)a		
Weight	0.328 (18)	0.882b (18)	
MCT Fatc	0.862b (20)	0.462b (20)	0.501b (18)

aNumber in parentheses represents the sample size for the correlation.
bCorrelation coefficient significant at P - 0.05.
cTissue fat of the mandibular cavity.

Table 3. Mean of percent of tissue of the femur marrow and of tissue fat of the mandibular cavity of white-tailed deer by visually estimated condition classes.

Condition class	Number	Mean % FMT fat	Mean % MCT fat
1 (Poor)a	7	77.0	63.4
2 and 3 (Fair to Good)	10b	90.5	78.6
4 (Excellent)	3	97.7	92.4

aGeneral condition classes based on work by Harris (1949).
bClasses were averaged due to the means for percent of tissue of the femur marrow and of tissue fat of the mandibular cavity of each class being nearly equal (difference of class 2 and 3 for FMT=0.03 percent, MCT=2.60 percent).

The means of the FMT and MCT for each of the three condition classes show that MCT separates better into condition classes than does FMT fat (Table 3). The above results are similar to those obtained by Baker and Leuth (1966). The decrease of MCT fat from condition class 4 to condition class 2-3, was 13.8 percent, while the decrease of FMT fat was only 7.2 percent between the same condition classes. The difference in the decrease of MCT fat and FMT fat was less, 12.5 percent to 15.2 percent, respectively, for the next two condition classes (Classes 2-3 and 1). These data also indicate the possibility that MCT fat was utilized prior to the utilization of FMT fat.

Right/Left Mandible Comparisons

A total of 53 lower jaws (106 mandibles) was extracted, and the percent MCT fat determined. The results of these extractions are presented in Table 4. The mean difference (D) of MCT fat levels in the left versus the right mandible of the same animal was 4.6 percent. In 24 animals, the left side of the mandible had a higher percent fat than the right side (D=4.3 percent). In the other 29 animals, the percent fat of the left side was lower than the right side (D=4.8 percent). Twenty-four individuals of the total sample could be placed into an age group consisting of animals 2.5 years or older. The other 29 animals were 1.5 years or less. The 2.5 years or older age group had a mean difference between fat levels of the left and right mandible of 2.9 percent, while the 1.5 years or less age group had a mean difference of 6.3 percent.

Table 4. Mean differences, confidence limits, calculated and tabular t-test values for the right/left mandible comparisons of individual white-tailed deer.

Group	Sample size	Mean difference (%)	C.L. P - 0.05 (%)	t 05(N-1) Cal. (tabular)
Total samples	53	4.6a	+1.3%	7.179 (2.021)
Left side higher than right side	24	4.3	+1.8	4.330 (2.069)
Left side lower than right side	29	4.8	+1.8	5.424 (2.042)
2½ years or older	24	2.9	+1.8	4.686 (2.069)
1½ years or less	29	6.3	+1.9	6.680 (2.042)

aFigures have been rounded to the nearest 0.1.

These analyses show that there is a difference in the MCT fat of the left and right mandibles of the same animal (D=4.6 percent). However, these differences were not significant.

The 2.5 years or older age group exhibited the lower mean difference between the MCT fat levels of the right and left mandible, while the 1.5 years or less age group exhibited the higher mean difference between these levels. Severinghaus (1949) noted that tooth eruption, hence mandibular growth, was not completed in the white-tailed deer until the animal was over 18 months of age. Therefore, the possibility exists that the difference of D between the two age groups (3.4 percent) is due to growth of the mandible and tooth eruption in the younger age group. Since those animals 2.5 years or older have ceased to have tooth eruptions, and for all practical purposes mandible growth, the figure 2.9 percent (+1.8 percent) difference between the left and right mandibles can be taken as the maximum average difference that would normally be expected between left and right mandibles. In the sample of 24 animals 2.5 years or older, only four individuals had greater than a 4.7 percent difference. The likelihood of a greater variability occurring in the younger age classes should be taken into account when comparing the MCT fat of samples of different age classes.

In addition, the overall 4.6 percent difference in the MCT of the right and left mandibles could be biologically significant if the difference were large enough to cause an animal to be incorrectly classified into a higher or lower condition class. It can be postulated that the 4.6 percent difference in the left and right mandible is biologically nonsignificant, since the present study and the study by Baker and Leuth (1966) found a 15 percent and 14 percent difference among the MCT fat levels of animals in the excellent, fair and poor condition classes.

Sectioned Mandibles

The ages of the animals from which mandibles were obtained to be utilized in this study were two animals 1.5 years old, two animals 2.5 years old, two animals 3.5 years old, and one 4.5 year old animal. The results of these extractions are presented in Table 5.

Considerable variation was exhibited among the sections of each mandible. Age appeared to have little effect on this variation, since all age groups exhibited deviations between sections. Due to these deviations, the sections were combined to form blocks of three sections each to determine if this procedure would obtain a sample of sufficient size, and approximate the percent MCT fat of the whole mandibular cavity tissue (Table 6). Block 1 (Fig. 2) exhibited the least mean difference (2.4 percent), block 3 the middle mean difference (2.6 percent), and block 2 the highest mean difference (2.7 percent). The lowest t-test value between block percent MCT fat and the whole mandible percent MCT fat was for block 1, while the highest t-test value was for block 3.

Statistically, the best sample that could be used to approximate the percent fat for the whole MCT was the first block (Sections 1/2/3). However, when mandibles are collected by the method used in this study (Marshall, et. al. 1964), there is a hazard that portions of blocks 1 and 3 will be lost (Fig. 2). Thus, block 2 (Sections 2/3/4) was chosen as the representative sample, since this block remains intact when the mandible is removed from an animal.

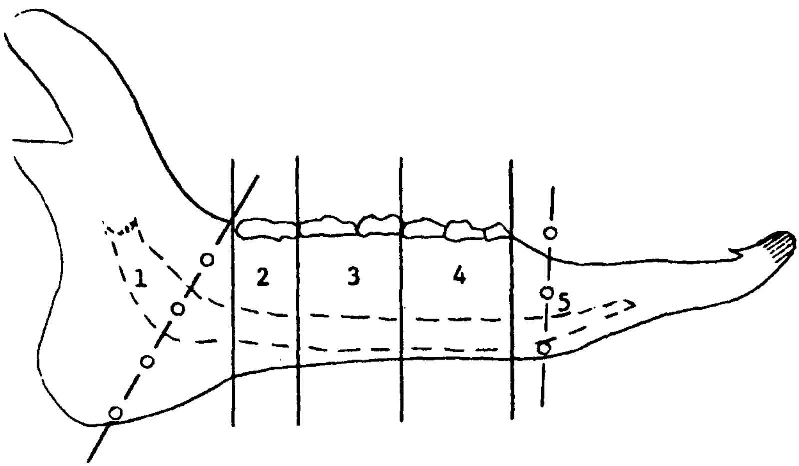

Figure 2. Diagram of sectioned mandible showing possible abnormal cuts and breakages using the standard method of mandible removal. Solid vertical lines ( ) divide sections. Dotted lines (---) indicate area of MCT. Numbers indicate the section number. Broken lines (—o—) indicate where breakage or cut could occur.

Table 5. Percent of tissue fat of the mandibular cavity of the sections of seven mandibles of white-tailed deer.

Section	Mandible tag number						
	360	374	377	2905	2917	2918	2920
1	74.5%	70.2%	92.5%	82.3%	69.6%	56.1%	81.6%
2	72.0	88.9	93.0	80.1	83.1	65.9	84.0
3	57.6	88.7	91.7	69.1	88.4	60.1	88.2
4	74.8	81.1	91.1	66.8	86.8	49.2	81.5
5	63.0	87.1	84.4	74.2	70.2	34.5	84.8
Mandible mean	66.6	83.2	90.5	74.5	79.6	53.0	84.0

Table 6. Percent of tissue fat of the mandibular cavity of the sections of seven mandibles of white-tailed deer by blocked sections.

	Block number 1	2	3	
	Sections in block			
Sample no.	1/2/3	2/3/4	3/4/5	1/2/3/4/5
360	68.0%	68.1%	65.1%	66.6%
374	82.6	85.9	85.6	83.2
377	92.4	91.9	89.1	90.5
2905	77.2	72.0	70.0	74.5
2917	76.7	86.1	81.8	79.6
2918	60.7	58.4	47.9	53.0
2920	84.6	84.6	84.8	84.0
Db	2.4%	2.7%	2.6%	
Cal. t-test	.737	.810	.844	

aTotal tissue fat of the mandibular cavity
bD is the mean difference of percent fat of each block and total tissue fat of the mandibular cavity

CONCLUSIONS

Tissue of the mandibular cavity was analyzed to determine if this fat deposit could be a reliable measure of condition in deer. The method of verifying this hypothesis was to compare the MCT fat to fat of the femur marrow. However, the problem encountered when FMT was used as a basis of comparison was that the FMT fat only indicated a narrow range of condition; that is, FMT fat only indicates when an animal is in poor condition (Riney 1955). Both the previous study by Baker and Leuth (1966) and the present study arrived at the same conclusion, that MCT fat, based on FMT fat comparisons, may be a useful indicator of condition, but cannot be definitely called such.

In the present study and the study of Nichols and Pelton (1972), MCT fat was more thoroughly analyzed than was MCT fat in the study by Baker and Leuth (1966). Nichols and Pelton (Op. cit.) found that MCT had a wide range of percent fat, 2.0 to 95.2 percent. Percent MCT fat varied according to age (with the lower age classes having lower fat levels) and sex (with females having higher fat levels). It was also found that MCT fat varied by date of collection. These changes in MCT fat and age, sex and date of collection follow very closely the changes of other known fat reserves and same variables (Harris 1945, Riney 1955). The above factors, therefore, indicate that MCT is a fat reserve, and thus could be used as an index of fat utilization and replacement.

A review of available literature indicates that the fat reserves in an animal's body are utilized and replaced in a certain order. When attempting to use MCT fat to determine condition, it is essential to know at what stage of this utilization and replacement order that MCT fat is used. Since the animals in this study were in varying degrees of condition, it is possible to look at fat utilization and offer conjecture as to the time of utilization of MCT fat as compared to FMT fat. As previously mentioned, the MCT fat was found to decrease prior to FMT fat (Table 4). The additional fact that MCT fat was more highly correlated to age, weight, and general condition than was FMT fat, would seem to indicate that MCT fat was utilized prior to FMT fat.

Data collected by Bischoff (1945) indicate that a fat reserve is useful as an indicator of condition only between the points of total fat utilization or replacement. The knowledge that femur fat is high, or subcutaneous fat is fully utilized, would only show that the animal is not in excellent or poor condition. The entire gradient of condition between excellent and poor would not be measured. With the knowledge of where each fat reserve fits into the utilization and replacement order, and the knowledge that a number of fat reserves are at a certain stage of utilization, the condition of the animal or population could be determined.

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FOOD PREFERENCES OF DEER IN LOUISIANA COASTAL MARSHES[1]

by

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ABSTRACT

Food preferences were determined for white-tailed deer *(Odcoileus viginianus)* in marshes and spoil arreas along the Louisiana coast by using feeding trials with captive deer and browse surveys. Fifty species were offered to 3 deer during the feeding trials. The species selected in largest amounts were *Leptochloa fascicularis, Scirpus olneyi, Iva annua, Echinochloa walteri*, and *Aeschynomene virginica*. Preferred food plants during the browse surveys along marsh levees were *Paspalum vaginatum, Mikania scandens, Bocapa monnieri, Panicum dichotomiflorum*, and *Leptochloa fascicularis*.

INTRODUCTION

Most studies on the food habits of white-tailed deer have been confined to upland areas. However, marshes and the associated ridges and spoil deposits provide excellent deer habitat, and population levels in certain areas along the Louisiana coast are among the highest in the state.

During earlier years the coastal marshes were a major stronghold for white-tailed deer; and, although this region made up only 12.9% of the land area of the state, St.

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