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IN VIVO MEASUREMENT OF THE CARCASS TRAITS OF MEAT TYPE RABBITS BY X-RAY COMPUTERISED TOMOGRAPHY

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Introduction

One of the main economic value of the rabbit is its dressing percentage and the amount of valuable meat parts of the carcass. According to economical calculations in Hungary 1 % increase of dressing percentage would mean 10 million Ft (about 125,000 USD) additional profit for a slaughter house killing 2 million rabbits per annum.

Carcass traits of broiler type rabbits could be determined up to now only by experimental slaughtering. Breeder candidate males were selected on the basis of their - minimum 20 - offsprings dressing percentage (Vrillon et al., 1979; Szendrő et al., 1988). Selection based on progeny test results is expensive and increases generation interval. Own performance testing based on body measurements regarding slaughter value gave very poor estimates (Bernarz and Frindt, 1975).

The utilization of X-ray computerised tomography (CT) to assess body composition in vivo is a non invasive way opened up new possibilities (Skjervold et al., 1981). The "norwegian school" proved in a great series of experiments how accurately body composition could be estimated by CT in pigs, sheep and fowl (Vangen and Kolstad, 1986; Sehested, 1985; Bensten and Sehested, 1989 and others summarized by Horn, 1991).

At our University a special digital imaging center have been installed utilizing also CT for quantitative in vivo body composition measurement to be used both in medical and animal sciences (Horn, 1991).

Based on our good experiences with other animal species (pigs, sheep, geese etc.) we started a selection program with rabbits based on CT scanning of breeder candidates. Since no basic data were available, in the first phase of our experiment we analized the relationship between some of the CT digital imaging information data gained on live rabbits and their subsequent carcass traits.

Materials and Methods

The experiment were conducted at Pannon Univ. Agric. Sci., Fac. Anim. Sci., Kaposvár.

We used Pannon White meat type rabbits. All animals were weaned at the age of 42 days, and were reared in flat-deck wire cages in groups of 5-6 thereafter. Nipple drinkers were used, commercial pellet and hay was fed ad lib.

In the reported experiment 55 rabbits were included, their age being between 12 and 13 weeks, liveweights showed little variation (2800 $\pm$ 50 g). All rabbits examined by CT were fixed in special plastic "baby" containers, no anaesthetics were needed. After the overall topogram of the animal was ready, we have taken CT slices or measurements from all rabbits at the following anatonical locations:

- width of Longissimus dorsi muscle
  - A = between the last dorsal and first lumbar vertebra,
  - B = between the 2nd and 3rd lumbar vertebra,
  - C = between the 4th and 5th lumbar vertebra,
- surface of L.dorsi
  - D = between the last dorsal and first lumbar vertebra,
  - E = between the 2nd and 3rd lumbar vertebra,
  - F = between the 4th and 5th lumbar vertebra,
  - G = between the 6th and 7th lumbar vertebra,
- surface of muscle on hind legs
  - H = at the head of femur
  - I = at the neck part of femur (immediately after head)
- length of vertebra
  - J = between the last dorsal and 7th lumbar vertebra,
- length of femur (K)
- calculated velues
  - L = E+F/2
  - M = L.J
  - N = I.K/3

All slaughter data were conducted according to Blasco et al. (1990). The following actual and derived (calculated) data were taken at the slaughter house after 24 hours fasting (from solids):

1 = standardized liveweight,
2 = liveweight after fasting,

3 = bloodless body weight,
4 = commercial skin weight,
5 = distal part of fore and hind legs,
6 = gastrointestinal tract weight (includes stomach and intestinal content but with empty bladder),
7 = liver weight,
8 = weight of kidneys, lungs, trachea and heart (edible organs),
9 = weight of fat around the kidneys,
10 = head weight,
11 = hot carcass weight (without head, liver, edible organs, and fat around the kidneys),
12 = weight of fore part (cutpoint: between the 7th and 8th ribs, following the prolangation of the ribs),
13 = weight of intermediate part (cutpoint: between the 6th and 7th lumbar vertebra),
14 = weight of hind part,
15 = weight of hind legs (without the part of vertebra),
16 = weight of meat on intermediate part (cutting the meat from bones by knife),
17 = weight of meat on hind legs (cutting the meat from the bones by knife),
18 = weight of blood,
19 = weight of carcass + head (11 + 10),
20 = weight of carcass + liver + edible organs + fat around the kidneys (11 + 7 + 8 + 9),
21 = weight of carcass + head+ liver + edible organs + fat around the kidneys (11 + 7 + 8 + 9 + 10),
22 = weight of intermediate + hind parts (14 +15),
23 = weight of meat on intermediate part + hind legs (16 +17),
24 = dressing percentage (without head, liver, edible organs and fat around the kidneys (11/2 x 100),
25 = dressing percentage (with head but without liver, edible organs and fat around the kidneys) (19/2 x 100),
26 = dressing percentage (with liver, edible organs and fat around the kidneys but without head) (20/2 x 100),
27 = dressing percentage (with head, liver, edible organs and fat around the kidneys) (21/2 x 100),
28 = percent of fore part in liveweight after fasting (12/2 x 100),

29 = percent of intermediate part in liveweight after fasting (13/2 x 100),

30 = percent of hind part in liveweight after fasting (14/2 x 100),

31 = percent of intermediate + hind parts in liveweight after fasting (22/2 x 100),

32 = percent of fore part in the carcass (12/11 x 100),

33 = percent of intermediate part in the carcass (13/11 x 100),

34 = percent of hind part in the carcass (14/11 x 100),

35 = percent of hind legs in the carcass (15/11 x 100),

36 = percent of intermediate + hind parts in the carcass (22/11 x 100).

The formula in the parenthesis says, e.g.:

$$21/2 \times 100 = \frac{\text{carcass + head + liver + edible organs + kidney-fat}}{\text{liveweight after fasting}}$$

Results and Discussion

In Table 1 we summarized the results taken in the slaughter house (weight and percent of different part of the rabbits). The various caracteristics, and their calculation is described in the Materials and Methods.

In the Table 2 we summarized the data gained by CT measurements. All designations are the same as given in Materials and Methods.

From the data it can be clearly seen that the width and surface of L.dorsi is the largest at the 3rd measuring point (between the 4th and 5th lumbar vertebra).

CT slices taken in the region of the hind legs considerable differences exist (29.25 vs. 44.44 cm^2) despite of the fact, that between two points (head and neck part of the femur) the distance is only 10-20 mm. The neck part of the femur is not an exact anatomical point so the surface of the muscle may differ significantly depending on the point of the CT slice measured by some mm forward or backward on the neck.

With M and N we tried to measure (estimate) the volume of the L.dorsi and muscle on the hind legs.

In Table 3 we summarized the correlations among the CT measurements and carcass traits.

The thickness of L.dorsi at different anatomical points (A, B and C) did not show significant or close correlations with carcass values so they are not good measurements to estimate the carcass traits.

The surface of the L.dorsi between the last dorsal and the 1st lumbar vertebra (D) were only sometimes significantly correlated with the carcass traits, but between the 6th and 7th lumbar vertebra (G) it was not correlated with carcass values. It seems that surface of the L.dorsi at these two anatomical points are not suitable for estimate the carcass traits.
The surface of L.dorsi between the 2nd and 3rd, and 4th and 5th lumbar vertebra (E and F) gave the closest correlations with the weight and rate of different parts of carcass. It can be concluded that the surface of L.dorsi E and F (or the mean of the two measurements, L) give the most exact estimation on the carcass yield of broiler rabbits.
The surface of hind legs at the head of femur (H) were not significantly correlated with any carcass traits, and at the neck part of femur (I) only sometimes were significantly correlated with the carcass traits. The reason for this is probably the neck part of femur is not an accurate anatomical point so it is important to determine a more exact point on the neck in the future. It seems that the measurement of H is not suitable for estimation of carcass traits, but we want to use the measurement of I as a compliment information to calculate an index value.
Neither the lenght of vertebra (J) nor of femur (K) were significantly correlated with the carcass traits. But we thing they will be useful to measure the volume of L.dorsi (M) and the muscle on the hind legs (N) to estimate more correctly the carcass values. The differences in weight of carcass (11), intermediate part (13) and intermediate + hind parts (22), and the percentage of carcass (24, 25, 26 and 27), the intermediate part in the liveweight(29) and in the carcass (31), between the two extremist measurements of L.dorsi (16-17 and above 22 cm^2) were 137, 70 and 118 g, and 2.61-3.11, 2.03 and 2.06 % respectively. Figure 1 shows the connection between surface of L.dorsi (L) and dressing percentage (27):
The present data show that the surface of L.dorsi between the 2nd and 3rd or 4th and 5th lumbar vertebra is a good estimator of carcass traits. More CT parameters constituting an index probaby will improve the exactness of the estimation.
In the next steps we will compare rabbits differing in liveweight, taking into consideration their CT and slaughter house data, and test new indexes.

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Table 1

Date of carcass traits

Carcass traits *	Average	s	Min	Max
1 g	2797	33	2750	2850
2 g	2594	55	2470	2700
3 g	2522	54	2410	2620
4 g	414	28	355	470
5 g	88	7	75	110
6 g	369	31	320	455
7 g	61	7	45	75
8 g	40	6	30	55
9 g	22	9	10	50
10 g	153	7	140	170
11 g	1356	44	1265	1470
12 g	406	18	360	445
13 g	425	21	370	490
14 g	511	23	450	550
15 g	483	22	430	525
16 g	281	21	240	330
17 g	357	18	315	395
18 g	72	12	40	90
19 g	1510	46	1410	1620
20 g	1479	46	1375	1585
21 g	1632	49	1530	1735
22 g	936	36	860	1040
23 g	637	34	580	725
24 %	52.29	1.38	50.2	55.4
25 %	58.20	1.47	55.7	61.3
26 %	57.01	1.28	54.6	60.0
27 %	62.93	1.35	60.4	66.0
28 %	15.64	0.57	14.3	16.7
29 %	16.39	0.77	14.5	18.4
30 %	19.72	0.82	18.1	21.0
31 %	36.10	1.26	33.7	39.0
32 %	29.91	1.04	27.7	32.1
33 %	31.34	1.06	28.6	33.7
34 %	37.70	1.08	35.2	39.7
35 %	35.64	1.01	33.3	37.5
36 %	69.04	1.09	66.4	71.2

Remark: The sence of figures are the same as given in Materials and Methods

Table 2

Data gained by CT measurement

CT traits	Average	s	Min	Max
A cm	1.86	0.15	1.55	2.15
B cm	1.93	0.14	1.60	2.30
C cm	1.94	0.17	1.45	2.35
D cm^2	14.74	2.07	9.91	20.07
E cm^2	17.90	1.75	14.76	22.92
F cm^2	20.42	1.88	17.41	25.39
G cm^2	17.26	2.06	13.57	22.66
H cm^2	29.25	4.00	25.21	46.01
I cm^2	44.44	3.86	35.48	52.97
J cm	10.99	0.52	9.30	12.00
K cm	7.31	0.38	6.20	8.10
L cm^2	19.14	1.66	16.42	23.71
M cm^3	210.33	21.24	165.33	265.55
N cm^3	109.75	8.81	91.70	126.20

Remark: The sense of letters are the same as given in Materials and Methods

Table 3

Correlations among CT measurements and carcass traits

		CT measurements *													
		A	B	C	D	E	F	G	H	I	J	K	L	M	N
Carcass traits *	1										-.44				
	2														
	3														
	4										-.41				
	5														
	6						-.44						-.39		
	7														
	8	-.53	-.40												
	9														
	10														
	11					.61	.66						.67	.58	
	12														
	13					.67	.71						.73	.66	
	14				.43	.43	.43						.45	.46	
	15				.45	.50	.47						.50	.50	
	16					.50	.58			.43			.57	.46	
	17				.41	.52	.48						.52	.44	.43
	18														
	19					.58	.65						.65	.56	
	20					.48	.57						.55	.42	
	21					.46	.56						.54	.41	
	22			.40	.40	.69	.72						.74	.70	
	23					.62	.65			.45			.66	.54	.43
	24	.45				.63	.62						.65	.67	.48
	25	.43				.58	.59						.61	.65	.52
	26					.52	.55						.56	.53	.48
	27					.49	.53						.53	.52	.52
	28														
	29					.67	.68			.40			.71	.70	
	30	.41												.43	
	31	.41		.39		.65	.63						.67	.72	.44
	32					-.44	-.46						-.47	-.51	
	33					.45	.47						.48	.46	
	34														
	35														
	36					.41	.39						.42	.49	

Remark: The sence of letters and figures are the same as given in Materials and Methods

Table 4

Connection between surface of L.dorsi (L) and carcass traits

Carcass traits *	Surface of L.dorsi (L), cm2													
	16-17		17-18		18-19		19-20		20-21		21-22		above 22	
	n= 5		8		13		15		5		5		3	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
11 (g)	1298	21	1327	34	1347	29	1369	41	1367	19	1379	34	1435	41
19 (g)	1446	22	1479	37	1504	33	1523	43	1523	14	1534	42	1590	44
20 (g)	1416	39	1446	41	1478	37	1496	40	1481	21	1496	41	1552	42
21 (g)	1564	37	1598	45	1632	39	1650	42	1637	17	1651	48	1707	45
13 (g)	393	15	414	15	420	15	432	15	426	10	440	15	463	31
16 (g)	255	14	274	14	276	23	285	16	276	17	301	7	312	28
22 (g)	882	22	915	29	931	21	944	28	946	17	966	32	1000	49
24 (%)	51.00	0.63	51.54	1.02	52.14	0.87	52.33	1.86	52.66	0.65	53.54	0.72	54.10	1.00
25 (%)	56.82	0.73	57.42	1.21	58.08	0.92	58.19	1.94	58.66	0.42	59.54	0.92	59.93	1.00
26 (%)	55.86	0.63	56.13	1.27	57.09	0.84	57.17	1.56	57.06	0.72	58.04	0.91	58.47	1.01
27 (%)	61.66	0.34	62.06	1.48	62.98	0.90	63.06	1.64	63.06	0.60	64.08	1.07	64.33	0.99
29 (%)	15.44	0.76	16.10	0.53	16.25	0.70	16.49	0.68	16.40	0.35	17.08	0.43	17.47	1.01
31 (%)	34.64	0.66	35.51	1.16	35.96	0.65	36.09	1.34	36.44	0.68	37.48	0.76	37.70	1.47
33 (%)	30.30	1.36	31.24	0.58	31.13	1.40	31.53	0.88	31.18	0.43	31.90	0.58	32.23	1.22

Remark: The sence of figures are the same as given in Materials and Methods

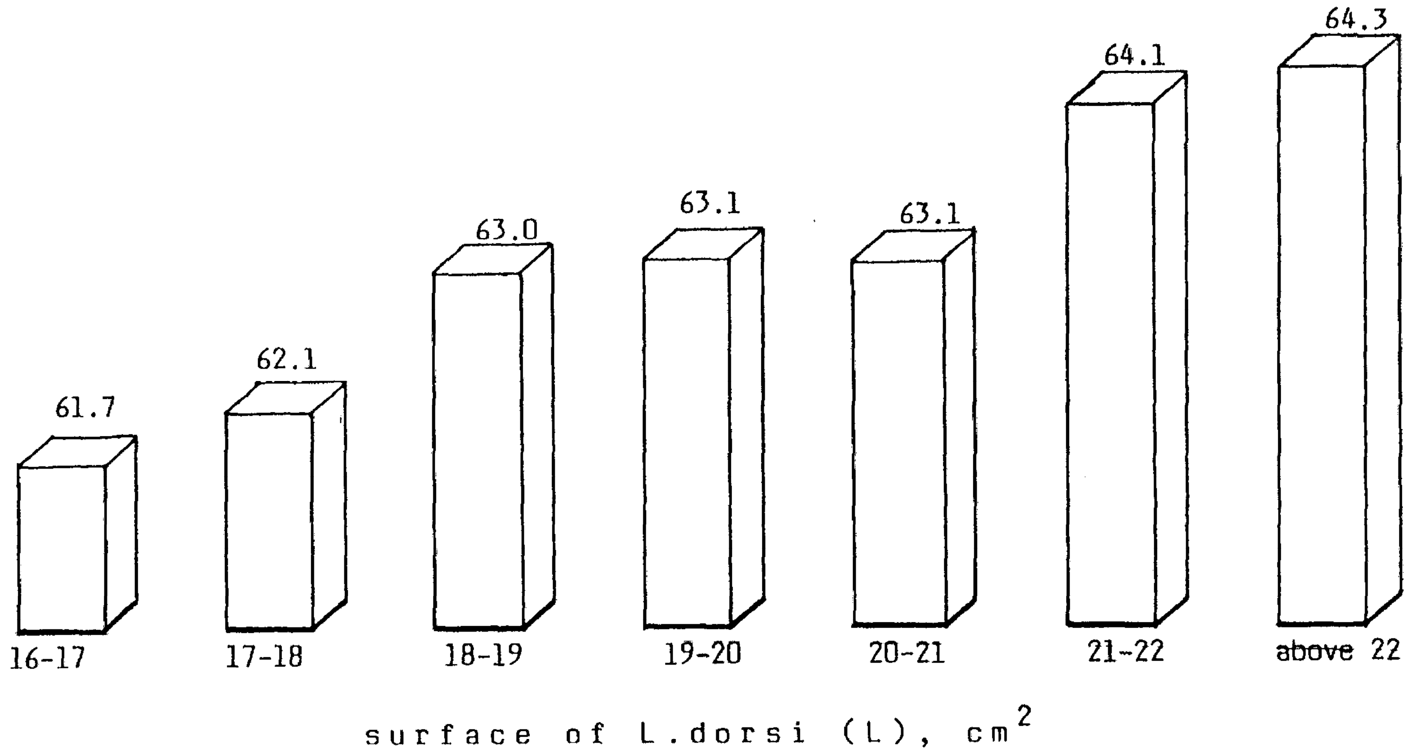

Figure 1 Connection between the surface of L.dorsi (L) and dressing percentage (27)