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LINEAR CARCASS MEASUREMENTS AS INDICATORS OF BODY FAT CONTENT IN THE PIG

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OPSOMMING: LINEÊRE KARKASMATE AS VOORSPELLERS VAN LIGGAAMSVETINHOUD BY DIE VARK

Hierdie studie is onderneem om die voeglikheid van verskeie karkasvetmate as voorspellers van totale liggaamsvet te ondersoek, om sodoende die tyd, arbeid en koste wat in beslag geneem word by die karkasevaluasie-tegnieke, te verminder.

'n Totaal van 33 Landras X Grootwit kruisings (kastrate) is as eksperimentele diere gebruik. Die diere is op een van 3 voedingsbehandelings vanaf 8 weke ouderdom tot slagouderdom grootgemaak, waarna hulle een uit elke behandeling twee weekliks vanaf 11 weke tot 31 weke ouderdom geslag is en die liggaamsamestelling deur middel van chemiese analises bepaal is. Lineêre mate op die gesplete karkas is gebruik om die verwantskappe tussen totale liggaamsvet en die lineêre karkasmate te bepaal. Die C en C + K vetmate was die beste aanduiders van totale liggaamsvet in die vark.

SUMMARY:

This study was undertaken to investigate the suitability of various carcass fat measurements as predictors of total body fat in the pig in order to minimize the time, labour and costs involved in carcass evaluation techniques.

A total of 33 Landrace X Large White crossbred castrates were used as experimental animals. The animals were allotted to one of three nutritional treatments at eight weeks and reared till they were slaughtered, one from each treatment fortnightly from an age of 11 weeks up to 31 weeks of age. After the animals were slaughtered, their body composition was determined by chemical analyses and linear measurements taken on the split carcass. The data were used to calculate the relationships between total body fat and linear carcass measurements. The C and C + K fat measurements were the best indicators of total body fat in the pig.

In order to determine the body and carcass composition of a pig, numerous methods have been used by research workers. The essence of all these investigations has been to establish relationships between the various parameters which can be used in estimating total fat or lean content in the pig, with the object of finding parameters that are easy to obtain, practical and inexpensive. In evaluating pig carcasses according to direct methods, numerous dissections and measurements are involved.

Complete dissection of the carcass is too expensive and time consuming. Simpler methods will thus be of great value in predicting carcass composition. According to Kempster (1976) the best parameter to use in practice is the one which will accurately predict the total body fat content and at the same time be reasonably easy to apply. An attempt was therefore made in this study to find the best linear measurement(s) which will predict most accurately the body and carcass composition in the pig taking costs and manpower involved into consideration.

Procedure

Experimental animals and diets

A total of 33 Landrace X Large White crossbred castrates were allotted to one of three regimes of feeding at an age of 8 weeks. They were castrated at 2 weeks, weaned at 3 weeks and reared as a litter group until 5 weeks old whereafter they were individually reared in flat deck type cages, fitted with self feeders and automatic water nipples. All piglets received the same creep feed (20% crude protein and an ME content of 14 MJ/kg DM) from a week prior to weaning up to 7 weeks of age, whereafter a standard growth meal (16,5% crude protein and a ME content of 14,85 MJ/kg DM) mixed with the creep feed on a 50 : 50 basis was fed until they were offered the experimental diets at 8 weeks of age (Table 1). Pigs were fed *ad libitum* at all times and had free access to water.

Feed intake and live masses were recorded on the same day at weekly intervals. Feed and water was not withheld before mass determination.

Diets 1 and 2 were computed to contain 20 % protein of equal quality and origin and known to be in excess of the requirements for optimum production. A dilution of the dietary energy content of Diet 2 was achieved by the replacement of maize starch by untreated pine wood sawdust. Diet 3 served as a control diet, representing the type of growth diet fed to growing pigs in South Africa.

Pigs in all the treatments were slaughtered one from each treatment at two-weekly intervals from an age of 11 weeks up to 31 weeks when the last pig in a treatment was slaughtered according to the slaughter procedures used by Rossouw, 1980.

Linear measurements

Fat measurements were taken:

- over the shoulder on the dorsal mid-line where the backfat was thickest
- over the mid-back on the dorsal mid-line where the backfat was thinnest
- over the loin area on the dorsal mid-line (three measurements)

The following measurements were taken on the cut surface of the mid-back:

- the C and K fat measurements, taken along the surface of the back over the eye muscle *(M. longissimus thoracis),* C being at a point 4,5 centimetres lateral from the centre line of the back and K being at a point on the same side 9,0 centimetres lateral from the centre line of the back.
- the surface of the *M. longissimus thoracis* (eye muscle area) was traced on transparent material for planimeter measurements (cm^2).

Table 1

Experimental diets

Diet No.		1	2	3
Dietary Component				
Yellow maize meal	kg	34	34	71
Fish meal	kg	26	26	12
Lucern	kg	–	–	10
Maize starch	kg	40	8	–
Wheaten bran	kg	–	–	5
Pine wood sawdust	kg	–	32	–
Salt kg		0,5	0,5	1,0
Na_2HPO_4	kg	0,3	0,3	–
Minerals and Vitamins		+	+	+
*Dietary Composition**				
Crude protein content	%	23,8	23,2	19,2
ME content MJ/kg DM**		16,97	11,49	14,85
Crude fibre content	%	1,5	22,7	5,6

* Determined on a DM basis

** Determined in a metabolism trail with six pigs per diet by Kemm (1975).

Determination of DM, nitrogen and ether extract

A "Wolfking" carcass grinder was used to grind the one side of a carcass 5 times in succession using 2 sieves, one with 12 mm holes and the other with 5 mm holes. The ground portions were samples while being mixed continuously to prevent moisture separation until 4 samples had been collected. A triplicate sample was then taken for DM determination.

A further 500 g sample of each carcass was freeze dried in a "KP Model 'Z" freeze drying apparatus until the sample had approximately 6% moisture. The dried sample was then manually divided into little blocks of between 1 and 2 cm in size and mixed with 3 and 4 times its volume of dried ice. The mixture was then ground in a laboratory mill through a 2 mm sieve. The frozen samples were thawed overnight at room temperature to allow for temperature and humidity equilibration before being analysed. Triplicate samples were weighed out for DM, nitrogen and fat determination. The samples used for fat determination were also used for ash analyses (Rossouw, 1980).

The remaining fractions of the pig body (head, trotters, intestine and blood) were treated and analysed in a fashion similar to that described above for the carcass. The data obtained was then used to calculate the total body composition.

Statistical analyses of the data

The logarithmic form of the allometric equation $(lny = a + blnx)$ was used to analyse the data. Co-variance analyses, standard deviations, and the coefficients of variation were determined between and within treatments. The significance of the slopes and intercepts between and within the treatments were also determined and tabulated.

Results and Discussion

Wiley, Paarlberg & Jones (1951), Hazel & Kline (1952) and Zobrisky (1954), reported that the yield of fat can be determined with a greater degree of ease and accuracy than the yield of lean in both the live pig and in the carcass. Zobrisky (1954) on the other hand found yield of fat to be as valuable as yield of lean for estimating carcass composition in the pig.

Table 2

Regression relationships between ln TBF and ln carcass measurements

x	y	Regression equation	r	Syx
TBF	C	y = 1,0571 + 0,6407 x	0,9021	0,3057
TBF^2	C + K	y = 1,9491 + 0,6155 x	0,8955	0,3050
TBF	TBT	y = 2,6484 + 0,5270 x	0,9722	0,1264

Table 3

Regression relationships between ln LM and the ln of the various linear carcass measurements

x	y	Treatment	Regression equation	r	Syx
C	LM	1 & 3	y = 3,0493 + 0,8169 x	0,9669	0,12
		2	y = 3,3171 + 0,8107 x	0,9734	0,11
C + K	LM	1 & 3	y = 0,0015 + 1,0400 x	0,9549	0,15
		2	y = 2,7599 + 0,8034 x	0,9617	0,14
TBT	LM	1 & 3	y = 0,0170 + 1,0000 x	0,9674	0,16
		2	y = 2,7483 + 0,7648 x	0,9548	0,50

x = ln carcass measurements (x 1000)
y = ln LM (x 1000)

Table 4

Regression relationships between ln TBF (kg) and ln LM (kg)

x	y	Treatment	Regression equation	r	Syx
TBF	LM	1 & 3	y = 5,6430 + 0,5600 x	0,9954	0,05
TBF_2	LM	2	y = 6,6631 + 0,4652 x	0,9908	0,07

x – x 1000

Table 5

Relative precision of the regression equations calculated for estimating TBF at various live masses (Treatments 1 & 3)

Live mass		90	86	60	50
x	y	kg	kg	kg	kg
TBF	LM	29,55	27,89	14,33	10,59
TBF	C	34,40	31,55	15,85	11,19
% Dev.		16,41	13,12	10,61	5,67
TBF	C + K	30,84	28,73	16,37	12,31
% Dev.		4,37	3,01	15,62	22,38
TBF	TBT	32,49	29,80	15,05	10,65
% Dev.		9,94	6,85	5,02	0,57

Linear carcass measurements as indices of total body fat (TBF)

As far as the eye muscle area was concerned a significant difference ($P < 0,05$) was found (co-variance analysis) between the intercepts of the regression relationships between ln TBF and ln eye muscle area of the different treatments. These differences could be due to the fact that there exists a possibility that eye muscle area, when measured at various positions, could be influenced differently by certain environments and each measurement has a degree of genetic independence (King, 1957). For this reason, eye muscle area was not considered further as a possible predictor of total body fat content.

Regression relationships between ln total body fat (TBF) and ln carcass measurements were determined and are presented in Table 2. The nutritional treatments imposed had no significant effect on the regression relationships. One regression equation could therefore be calculated for all the pigs.

The data revealed the linear carcass measurements to be highly correlated with TBF. The C-fat measurement showed a higher correlation (0,9021) than the C + K fat measurement (0,8955) to TBF since the usefulness of the K fat measurement depended on the shape of the eye muscle (Joblin, 1965). As far back as in 1934, Hankins & Ellis found the correlation between backfat measurements and total body fat to be as high as 0,84.

Regression relationships were also calculated between ln live mass (LM) and the ln of the carcass measurements (Table 3). An analysis of covariance revealed that there was no significant difference between treatments 1 and 3. One regression equation was therefore calculated for these 2 treatments, which in turn showed a highly significant ($P < 0,01$) difference with Treatment 2. The data in this study indicated that although backfat measurements are highly correlated with live mass (Table 3), one cannot extrapolate beyond a specific nutritional treatment.

These high correlation coefficients could be due to the fact that the linear measurements were taken over a wide range of live masses (22 kg to 121 kg). If this range of live mass had been restricted it is possible that these high correlation coefficients would not have been obtained.

Relative precision of the regression equations calculated for estimating total body fat

Hofmeyr, Roux & Olivier (1974) and Kemm & Ras (1976) verified the principle shown by Reid *et. al* (1968) that a close relationship exists between LM and TBF in the pig. Since TBF was determined with extreme accuracy in this study (chemical method) it is assumed that TBF at any given live mass is accurately predicted by either of the regression equations presented in Table 4, for pigs from treatments 1 and 3 and 2 respectively.

The data summarized in Table 5 illustrates the degree of precision that could be expected when TBF is predicted with the equations presented in Table 2, for Treatments 1 and 3.

The data in Table 5 was calculated as follows:

- TBF for live masses between 50 and 90 kg were chosen.
- The TBF content at the various live mass stages, indicated above, were calculated with the use of the regression equation in Table 4.
- The regression equations presented in Table 3 were used to calculate C, C + K and total back fat thickness (TBT) for each live mass (LM).
- The regression equations presented in Table 2 were then used to calculate TBF from C, C + K and TBT for the various live masses.
- Differences in TBF obtained from the regression equation between TBF and LM and those calculated from the regression equations between the various carcass measurements and TBF were expressed as a percentage deviation from the TBF calculated from the equation $y = 5,6430 + 0,56\ x$ (Table 4).
- The parameter with the lowest percentage deviation was taken to be the best predictor of TBF.

Table 5 indicates that TBF predicted from the C fat measurement showed the smallest percentage deviation (5,67%) at a live mass of 50 kg, and it also indicates that when all the live mass values were considered the C measurement as a predictor of TBF showed the smallest percentage deviation at the lower live masses. The most accurate predictor of TBF for live mass intervals of between 86 to 90 kg in this study was found to be the C + K fat measurement.

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