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PREDICTION EQUATIONS FOR MEAT CHEMICAL COMPOSITION IN GROWING RABBITS

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INTRODUCTION

An ideal approach to the study of meat animals composition requires a complex carcass disecction and chemical analysis. Some limitations associated with these methods are its high cost and labour intensivity, the variations due to dissection and analysis techniques, and its rare application for commercial purposes (HEDRICK, 1983).

Methods based on indirect measurements have been proposed for use on live animals, e.q. body weight, body measurement, ultrasonic or radioactive techniques, or on animal carcass, as area and linear measurements, sample cuts and specific gravity. Indirect measurements are used to compute prediction equations of animal composition. The usefulness of these equations depends, first on its objectives, prediction on a short lifetime interval, like slaughter age, or prediction on a wide interval as in growth studies (DELTORO and LOPEZ, 1985). Second, depends on its capability of making proper predictions on populations with different sex, age, strains, mature weights, feeding systems or fattening grades (HEDRICK, 1983).

Chemical composition of rabbit meat has been studied at slaughter age (OUHAYOUN and POUJARDIEU, 1978) or weight (OUHAYOUN et al., 1979) and over wide lifetime periods like suckling period (FRAGA et al., 1978; TORRES et al., 1976) post-weaning period (OUHAYOUN et al., 1985; BLAS et al., 1977) or from birth to different ages (DELTORO and LOPEZ, 1987; RODRIGUEZ et al., 1983; VIGNERON et al., 1971). Prediction equations derived in many of those papers were generally based on predictor variables that can be easily measured, as body weight, carcass weight or body measurements but the predictive value of some equations is limited to individual components (moisture or fat content). Other papers (BLAS et al., 1977; RODRIGUEZ et al., 1983) also used moisture or fat content as predictor variables with samples obtained by griding whole carcass, but their method is not practical for commercial use.

Sex, strain or feeding system effect on rabbit meat composition has been studied by some researchers (VIGNERON et al., 1971; TORRES et al., 1976) but papers that considering sex, strain and other factors simultaneously over a period from birth to mature weight and that have prediction value on practical bases are scarce.

The objective of this paper was to compute prediction equations for rabbit meat absolute and relative composition, for animals from two strains and both sexes, slaughtered from one to twenty weeks of age, using a maximum of 3 predictor variables.

MATERIAL AND METHODS

A sample of 320 rabbits from two strains, New Zealand White (NZ) and California (CA), and both sexes, salughtered at weekly intervals from 1 to 20 weeks of age were used. In order to use animals at the same degree of maturity (NOTTER et al., 1983) at each slaughter point, only animals whose body weight (BW), irrespective of their strain and sex, was around ±15% of mean weight of base population were included in the experiment.

Skin, urinary bladder and digestive tract were removed after slaughter in order to obtain empty body weight (EBW). The carcass was left at environmental temperature until a complet bleeding (2-4 h) and then it was weighed. After 24 hours at $4^{o}C$, carcass weight (CW) was obtained and the following measurement were taken: carcass length (CL) from atlas to last lumbar vertebra, carcass width (CWD) between the third trochanter of each femur, and carcass circumference (CC), including abdominal wall, at the seventh lumbar vertebra. Organs, subcutaneos (SF) and body cavity fat (CF) and head (H), seccioned at axis level, were removed and weighed and the rest of the carcass was halved.

All the meat from the right side was dissected and weighed in order to estimate total meat (TM) in the carcass. The left side was split and weighed as follows: breast ans ribs (BR), cut at the join between the last thoracic and the first lumbar vertebrae, loin (L), including sacral vertebrae, abdominal wall (AW), foreleg (FL) including the muscles of insertion in the trunk and hind leg (HL) including the corresponding part of the sacral bone. Total fat (TF) was considered as the sum of SF and CF.

Chemical analysis on TM and meat from L and HL were carried out by duplicate. Dry matter and ether extract were determined by standard methods (Association of Official Analytic Chemists, 1980) and protein (nitrogen x 6.25) by macro-Kjeldahl using a semiautomatic analyser, Tecator 1005, and a destiller, Kjeltec 1003.

Statistical analysis for chemical composition, in grams and percentage, were made using stepwise multiple regression (DRAPPER and SMITH, 1981). A maximum of three independent variables on final equation was accepted if and only if the new variable increased the R^2 value in at least .005 in relation to the previous variable in the regression, in order to obtain prediction equations of practical use. Differences due to sex and strain were studied using the F-test.

The regression equations were computed considering three groups of predictor variables in accordance with the difficulty of their measurement. The first group of variables including those that were taken on live animal or on complete carcass: BW, EBW, CW, CL, CWD and CC. On the second group, variables from partitioned carcass and fat depots were added: H, BR, L, AW, FL, HL, SF and CF. Finally variables from chemical analysis were added: absolute protein, fat and water content (grams) on HL (PHL, FHL, WHL) and L (PL, FL, WL) and relative content (%) on HL (PDHL, FPHL, WPHL), and L (PPL, FPL, WPL).

Predicted variables, related to TM, were absolute (grams) and relative (%) protein, fat and water content (PTM, FTM, WTM) and (PPTM, FPTM, WPTM) respectively.

RESULTS AND DISCUSSION

High correlation coefficients between absolute meat composition predicted variables and all predictor variables were estimated. The only exception being predictor variables related to relative composition of meat from HL and L. Among the first group of predictor variables considered, CW showed the strongest relationship with absolute content of water, fat and protein on TM (.994, .899 and .990 respectively). Among variables from partioned carcass HL had the highest correlation with absolute protein and water content (.993 and .997) and CF with fat content on TM (.906). Relationship between predictor variables from first and second groups and total meat relative composition were considerably lesser than those for absolute composition. With respect to the association between predictor variables from chemical analysis and total meat composition, the highest correlation coefficients were found between HL components and the respective components on TM when both were considered on the same bases (absolute or relative composition).

PREDICTION OF ABSOLUTE MEAT COMPOSITION.

Prediction equations for FTM, PTM and WTM using predictor variables from the three groups stated above are presented on Table 1.

In the case of PTM and WTM, high determination coefficients were obtained from the first group of variables, CW being the only variable used in prediction meanwhile for FTM another measurement of body growth, CL, was added and the R^2 was lower than those for PTM and WTM.

BW or EBW have been used by some authors to predict absolute composition and its value as predictor variables is generally higher for protein and water than for fat content (VIGNERON et al., 1971; TORRES et al., 1976; FRAGA et al., 1878; RODRIGUEZ et al., 1983). In this paper, CW was prefered to BW and EBW because the differences due to the content of urinary bladder, digestive tube, blood and skin weight were eliminated. When predictor variables from partioned carcass were added the determination coefficientes increases, especially that related to the FTM equation. The residual standard deviation decrased in all cases.

Prediction of PTM and WTM when the second group of predictor variables were considered, used HL as predictor, that was the heaviest part of the carcass from 2nd to 20th week of age. HL had also the highest meat/bone ratio. Prediction of FTM included the two dissected fat depots and BR weight.

TABLE 1. PREDICTION EQUATIONS FOR ABSOLUTE MEAT COMPOSITION (gr) USING 3 GROUPS OF PREDICTOR VARIABLES.

Y	EQUATION	R^2	R.S.D.*
First group			
FTM	32.481-2.356 CL+0.706 CW	0.8539	9.66
PTM	-12.972+0.131 CW	0.9814	10.50
WTM	-33.683+0.457 CW	0.9892	27.62
Seconf group			
FTM	-3.565+0.736 CF+1.108 SF+0.107 BR	0.9310	6.65
PTM	-6.936+0.444 HL	0.9868	8.83
WTM	-12.548+1.541 HL	0.9949	20.67
Third group			
FTM	1.583+0.397 CF+2.272 FHL+2.923 FL	0.9604	5.04

* Residual Standard Deviation

The inclusion of variables from chemical analysis only improve the R^2 in FTM equation. This equation included the major fat depot and the absolute fat content of the heaviest parts of the carcass (HL and L).

PREDICTION OF RELATIVE MEAT COMPOSITION.

Table 2 presents prediction equations for relative meat composition.

Prediction equations using predictor variables from live animal or whole carcass and from partioned carcass showed R^2 values under 0.65, then its predictive value are limited.

When variables from chemical analysis were considered the R^2 increased to values between 0.8090 for FPTM and 0.8895 WPTM. Predictor variables included in equations were those that were taken from chemical analysis of the major meat component of the carcass (HL) and in the case of FPTM adn WHTM, CL and CF were also included.

TABLE 2. PREDICTION EQUATIONS FOR RELATIVE MEAT COMPOSITION (%) USING 3 GROUPS OF PREDICTOR VARIABLES.

Y	EQUATION	R^2	R.S.D.*
First group			
FPTM	16.962-0.316 CL-1.762 CWD+ 0.009 CW	0.5802	1.20
PPTM	16.494+0.140 CL-0.0009 CW	0.3087	0.99
WPTM	62.332+0.009 CW+1.897 CWD+0.257 CL	0.4204	1.59
Second group			
FPTM	13.637-0.417 CL+0.075 CF+0.021 L	0.6331	1.12
PPTM	17.165+0.099 CL-0.071 SF	0.3147	0.98
WPTM	65.518+0.391 CL-0.075 CF-0.023 L	0.4809	1.50
Third group			
FPTM	3.163-0.069 CL+0.045 CF+0.55 FPHL	0.8090	0.81
PPTM	2.231+0.434 PPHL	0.8540	0.40
WPTM	-15.228+0.110 CL-0.04 CF+0.571 WPHL	0.8895	0.60

* Residual Standard Deviation

The inadequate prediction of relative composition with respect to absolute composition has been reported previously (BLAS et al., 1977; FRAGA et al., 1978).

EFFECT OF SEX AND STRAIN.

In order to determinate the differences between regression equations for sex or strain groups, a serie of F test were carried out.

No differences between equations for water and protein due to sex or strain were detected, the only exception being WTM when predictor varibles from partitioned carcass were considered. In this case significant differences (P 0.05) were found between regressions for CA and NZ strains. With respect to prediction equations for fat content, differences between strains were found in all cases but FTM when the second group of predictor variables where used. Differences due to sex were detected for FTM when using predictor variables from first and second groups.

A higher growth of adipose tissue in females has been mentioned (CANTIER et al., 1969; LOPEZ, 1987). The former author has related this higher growth with an earlier starting of fast fattening phase and a higher fattening rate in females.

CONCLUSION

These results suggested that an adequate prediction of absolute protein and water content can be carried out using simple measurements on carcass, like CW. In places where the carcass is partitioned for market, the weight of HL improves the R^2 values associated to the prediction equations. These equations can be used irrespective of the strain and sex when the mature size of animals is similar and comparisons are made at the same degree of maturity.

Prediction of relative water and protein content in rabbit meat is difficult and it is necessary to use chemical analysis in order to obtain determination coefficients and residual standard deviations of adequate size. Absolute fat content can be predicted only using variables from chemical analysis of HL and L meanwhile relative fat content can not be predicted with accuracy. Specific prediction equations for fat content must be computed for each sex or strain.

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Predicction equations for absolute (grms) and relative (%) composition of rabbit meat were computed using 320 rabbits of 2 strains (California and New Zealand White) and both sexes. They were slaughtered at weekly intervals at between 1 to 20 weeks of age. Three groups of predictor variables were considered in accordance with the difficulty of their measurement. The first group refers to the variables from live animal or whole carccass, in the second group variables from partitioned carccass were added and in the last group variables from chemical analysis were also included. Statistical analysis were made using stepwise regression, and the differences between equations due to sex or strain were studied using the F test. Absolute protein and water content can be predicted using carccass weight ($R^2 > .981$) or hind leg weight ($R^2 > .986$) as predictors, meanwhile absolute fat content required the wight of body cavity fat and the absolute fat content of hind leg and loin for obtaining similary R^2 values ($R^2 = .9601$). Predicctions of relative composition of meat were more difficult than absolute composition, if being necessary to use the relative contents of water, protein and fat of the hind leg to achieve R^2 values between .80 and .89. No differences between equations for water and protein due to sex or strain were detected, the only exception being that of absolute water content when predictor variables from partitioned carccass were considered. Relation to fat content prediction equations, all of them showed differences due to sex or strain. This reason and the moderate R^2 values set up serious limitations for predicting meat fat content.

PREDICCION DE LA COMPOSICION QUIMICA DE LA CARNE DE CONEJO

Se calcularon ecuaciones de predicción de la composición absoluta (gramos) y relativa (%) de la carne de conejo. Se usaron 320 animales de 2 líneas y ambos sexos sacrificados a intervalos semanales entre 1 y 20 semanas de edad. Se consideraron 3 grupos de variables predictoras en función de la facilidad de su medida: sobre el animal vivo o la canal entera, sobre partes de la canal y las provenientes del análisis químico. Las diferencias entre regresiones debidas al sexo o la línea se examinaron con pruebas F. El contenido absoluto de agua y proteína se puede predecir adecuadamente a partir del peso de la canal ($R^2 > .981$). En el caso del contenido absoluto de grasa fue necesario incluir variables de los 3 grupos para obtener ajustes similares ($R^2 = 96$). La predicción de la composición relativa fue menos precisa y requirió variables predictoras de los 3 grupos considerados. El sexo y la línea afectaron todas las ecuaciones de predicción del contenido de grasa.