Proceedings 4th World Rabbit Congress, 10-14 October 1988, Budapest Hungary, Vol. 2, 361-369

QUANTITATIVE GROWTH OF BONE AND MUSCULAR TISSUES IN MEAT RABBITS

J.S. Vicente, J.L. Peris y J. Camacho.

Dpto. Ciencia Animal. Universidad Politécnica de Valencia
Camino de Vera, 14. 46022 Valencia. Spain

INTRODUCTION

Rabbit meat production has been strongly increased during the last years. It is due to its high prolificity and growth rate and its better meat quality than other farm animals. However, the information about their growth patterns is still limited. Most of papers on quantitative rabbit growth are reffered to body weight or carcass weight (LEHMAN, 1980; SAGER, 1983; RUDOLPH and SOTTO, 1984), meanwhile works on growth patterns of total fat, total bone and total lean are rare and only few exceptions are reffered to long intervals of time (VIGNERON et al. 1971; PALANSKA et al., 1981; LEBAS and MATHERON, 1982). Knowledge about those patterns is important since they affect the commercial values of rabbit carcass or rabbit meat and for that reason it should be considered for determining the optimal slaughter moment.

Some growth models could be used to study growth patterns (FITZHUGH, 1976; SAGER, 1983; RICHARDS, 1969; KNIZETOVA et al., 1983; BROWN, FITZHUGH and CARTWRIGHT, 1976). However, Richards' general model seems to be the most proper one (FITZHUGH, 1976). Using this model, the aim of this paper was to study the evolution of weight, maturity degree and relative growth rate of body weight, empty body weight, total fat, total bone and total lean in rabbits they were between 1 to 25 weeks of age.

Proceedings 4th World Rabbit Congress, 10-14 October 1988, Budapest Hungary, Vol. 2, 361-369

MATERIAL AND METHODS

This work was based on sample of 100 female rabbits from a synthetic strain, using a cross-sectional design. Animals were slaughtered at weekly intervals from 1 to 25 weeks of age.

The mean growth curve of the base population was established and then 100 rabbits, selected at random from those whose weight at the moment of the slaughter was around $\pm$ 10% of these mean values, were selected for the experiment. Those chosen animals followed similar growth curves and comparisions could be made at the same maturity degree (McCLELLAND, BONAITI and TAYLOR, 1976; NOTTER, FERRELL and FIELD, 1983).

The animals were weighed before the slaughter. Once the animals had been slaughtered and bled, the skin, feet, head, organs, alimentary tract and fat depots were removed. Empty body weight was calculated as the difference between body weight and the contents of alimentary tract and urinary bladder. The carcass was stored at 4^{o} C for 24 h, then it was separated into muscular and bone components, and then weighed. Total fat was considered to be the sum of single fat depots (subcutaneous, scapular, perirrenal and caul).

Richards' growth model was fitted to ours data, since it had demonstrated the best fitness in previous works (LOPEZ, 1987). Using Richards' equation, the estimated parameters, weight, maturity degree, and growth rate were studied.

RESULTS AND DISCUSSION

Estimated values for Richards' growth parameters and the coefficients of determination are presented on table 1. All the traits showed R^2 values greater than 0.93 being smaller for total fat. Body weight and empty body weight achieved similar R^2 values, despite of the fact that the variation due to urinary bladder and digestive tract contents was eliminated for empty body weight.

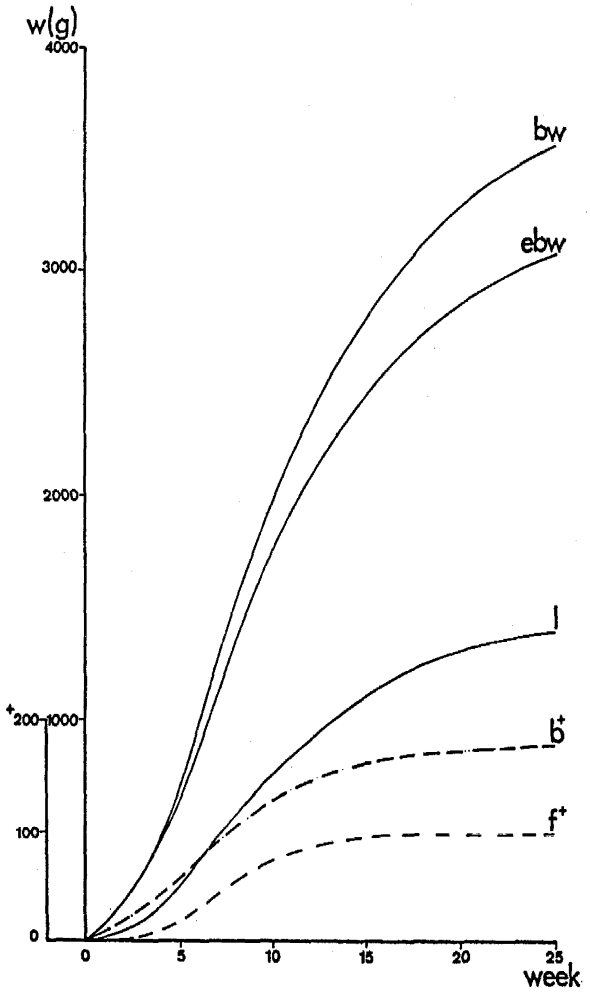
Using Richards' equation parameters mentioned above, weight, maturity degree and relative growth rate values for body weight, empty body weight, total lean, total fat and total bone were estimated (FITZHUGH, 1976).

Body weight and empty body weight showed a divergent trend that was increased since 4 weeks of age (Fig. 1), it coincided with the solid food intake increment. Both, body weight and empty body weight, did not achieve their mature weight during the experimental period but their maturity degree at 25 weeks of age was 0.92.

Total lean/total bone ratio was increased during the experimental period from 2.98 to 8.61. These values were higher than those reported by DELTORO and LOPEZ (1986) and PRUD'HON, VEZINHET and CANTIER (1970). As empty body weight and body weight as total lean did not reach its mature weight being its maturity degree of 0.92 at 25 weeks of age. Total fat and total bone weight were increased until they completed their growth at 19 and 20 weeks of age, respectively (Fig. 1). Their maturity degrees at 25 weeks of age, were 0.99 in both cases. Related to total fat, LOPEZ (1987) reported that it did not show and asymptotic phase. The former author suggested that sygmoid-shaped models with a final asymptotic phase were not proper to describe fat growth and it was related to the fact that fat depots act as energy reserves and their weights depended on many environmental factors.

	A	b	k	n	R^2
Body weight	3978,92	-1,04	0,135	-0,50	0,9893
Empty body weight	3362,37	-1,05	0,139	-0,53	0,9859
Total lean	1533,63	-1,14	0,134	-0,42	0,9746
Total bone	183,03	-0,16	0,235	-0,05	0,9593
Total fat	96,67	-1,38	0,322	-0,21	0,9331

Fig. 1: Weight evolution of body weight (bw), empty body weight (ebw), total lean (l), total bone (b) and total fat (f).



(+) Curves drawn on a different scale.

All traits reached their inflection point between 5 and 6 weeks of age, but their maturity degrees were different, being for body weight (0,25), empty body weight (0,24) and total lean (0,24) smaller than those for total bone (0,36) and total fat (0.32).

In relation with the maturity degree trend (Fig. 2), total bone showed a higher maturity degree values than those for total lean, empty body weight and body weight during all experimental period. The clear earliness of bone agrees with previous results of BUTTERFIELD et al. (1983a, 1983b). In relation to total lean, body weight and empty body weight, their maturity degrees showed a similar evolution. The parallelism observed for total lean and total bone maturity degrees confirms the functional relationship that exits between them. During the first 4 weeks of age, total fat was more overdue than the other traits. Between 4 and 7 weeks of age it was only more overdue than total bone. From then on this trait was the earliest.

Relative growth rate values of all traits decreased exponentially during the experimental period (Fig. 3). It disagrees with the general sygmoid tendency reported by LOPEZ (1987), however in both studies total lean always presented higher relative growth rate values than chosen for total bone. In relation to total fat, it presented higher relative growth rate values than those for total lean and total bone during the first 9 and 12 weeks of age, respectively. Relative growth rate values of body weight were always slightly higher than those for empty body weight. Both traits followed a parallel trend respect to total lean.

CONCLUSION

Weight followed the general sygmoid-shaped curves for all traits, however, only total bone and total fat reached their mature weight. Maxima relative growth rate values were reached between 5-6 weeks of age but maturity degree values were different.

Total bone showed a clear earliness and a lower relative growth rate values than the other traits did. In view of the observed total

Fig. 2: Maturity degree trend of body weight (bw), empty body weight (ebw), total lean (l), total bone (b) and total fat (f).

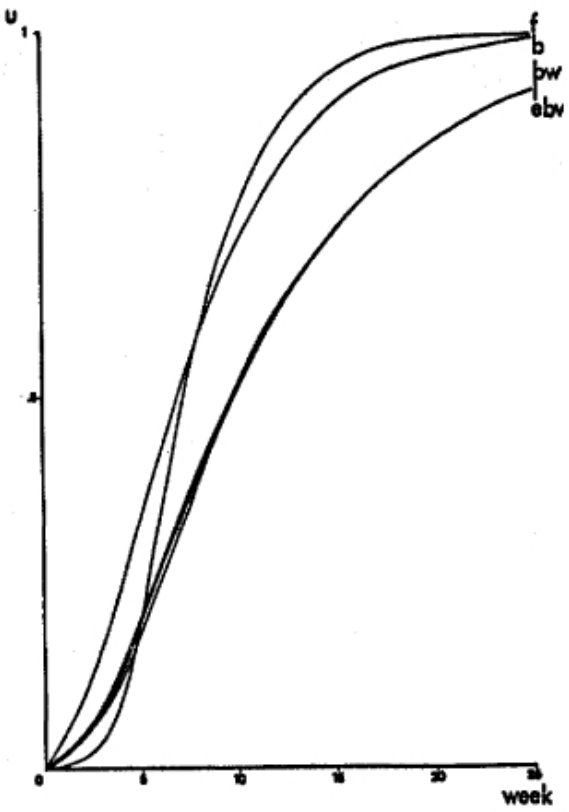
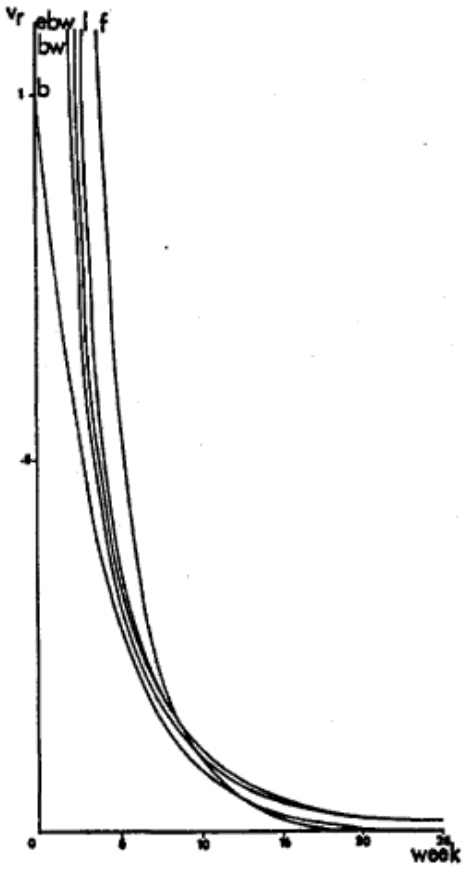


Fig. 3: Relative growth rate trend of body weight (bw), empty body weight (ebw), total lean (l), total bone (b) and total fat (f).



lean/total bone ratio it would be convenient to delay the time of the slaughter moment that nowadays is between 10-11 weeks of age.

ACKNOWLEDGEMENTS

Our most sincere acknowledgement to the late Dr. Javier Deltoro who offered us his helpful guide and confidence without it, this work wouldn't have been possible.

REFERENCES

BROWN, J.E.; FITZHUGH, H.A.; CARTWRIGHT, T.C. 1976. A comparison of nonlinear models for describing weight-age relationships in cattle. J. Anim. Sci. 42: 810-818.

BUTTERFIELD, R.M.; GRIFFITHS, D.A.; THOMPSON, J.M.; ZAMORA, I.; JAMES, A.M. 1983a. Changes in body composition relative to weight and maturity of large and small strains of Australian Merino rams: muscle, bone and fat. Anim. Prod. 36: 29-37.

BUTTERFIELD, R.M.; ZAMORA, J.; JAMES; A.M.; THOMPSON, J.M.; WILLIAMS, J. 1983b. Changes in body composition relative to weight and maturity in large and small strains of Australian Merino rams. 2. Individual muscle and muscle group. Anim. Prod. 36: 165-174.

DELTORO, J. y LOPEZ, Ana M. 1986. Development of commercial characteristics of rabbit carcasses during growth, Liv. Prod. Sci. 15: 271-283.

FITZHUGH, H.A. 1976. Analysis of growth curves and strategies for altering their shape. J. Anim. Sci. 42 (4): 1036-1051.

KNIZETOVA, H.; KNIZE, B.; HYANEK, J.; SILER R., HYANKOVA, L.; PLACHY H.; VILHELMOVA, M. 1983. Growth curves of highly inbred lines of fowl and their F_1 Hybrids.

LEBAS, F.; MATHERON, GF. 1982. VIII Rabbits. Liv. Prod. Sci. 9: 235-250.

LEHMANN, R. 1980. Application of a growth model in animal nutrition. 4 Body composition. Arch. Tierernöhrung, 30: 575-584.

LOPEZ, A.M. 1987. Estudios sobre el crecimiento en el conejo. (Studies on rabbit growth). Doctoral Thesis. Universidad de Valencia. Spain.

McCLELLAND, T.H.; BONAITI, B.; TAYLOR, S.C. 1976. Breed differences in body composition of equally mature sheep. Anim. Prod. 23: 281-293.

NOTTER, D.R.; FERRELL, C.L. and FIELD, R.A. 1983. Effects of breed and intake level on allometric growth patterns in ram lambs. J. Anim. Sci. 56 (2): 380-395.

PALANSKA, O.; SELNIK, J. GAZO, M.; PALENIK, S. 1981. A study of physical, chemical and biochemical properties of the skeletal musculature of the domestic rabbit during the course of post-natal development. Fleischwietschaft, 61: 1-6

PRUD'HON, M.; VEZINHET, A.; CANTIER, J. 1970. Croissance qualités bouchères et cout de production des lapins du chair. B.T.I. 248: 203-221.

RICHARDS, F.J. 1969. The quantitative analysis of growth. (In: Plant physiology, 1-76). F.C. Steward Ed.

RUDOLPH, W, and SOTTO, V. 1984. A modified Janoschek equation for postnatal growth of new Zealand White rabbits. III Congreso Mundial Cunicultura. Roma. II: 562-569.

SAGER, G. 1983a. Mathematical formulations of rabbit weight growth after data from Templeton (1955). II Congreso Internacional Rostock 79-86.

VIGNERON, P. BARON R. and DAUZIER, L. 1971. Evolution postnatales de la quantité d'eau et de lipides du corps et du grand psoas chez le lapin. Ann. Biol. Anim. Bioch. Biophys. 11: 669-679.

Proceedings 4th World Rabbit Congress, 10-14 October 1988, Budapest Hungary, Vol. 2, 361-369

QUANTITATIVE GROWTH OF BONE AND MUSCULAR TISSUES IN MEAT RABBIT

J.S. Vicente, J.L. Peris y J. Camacho
Dpto. Ciencia Animal. Universidad Politécnica de Valencia (ETSIA).
Camino de Vera 14. 46022-Valencia. Spain

A sample of 100 rabbits from a synthetic line in a cross-sectional design were used. The rabbits were slaughtered at weekly intervals at between 1 and 25 weeks of age. Empty body weight (EBW) was body weight (BW) minus the contents of alimentary tract and urinary bladder. Once the animals had been slaughtered and bled, the skin, feet, head, organs, alimentary tract and fat depots were removed. The carcass was stored at 4°C for 24 h, then, its muscular and bone components were separated. Data was analysed with the Richards' growth model, since it had demonstrated the best fitness in previous works. From Richards' equation, maturity degree (u), absolute growth rate (AGR) and relative growth rate (RGR) were studied. EBW and BW had a similar trend, they reached their maximum AGR between the 5th and 6th weeks of age (u=0.24). From 20 weeks of age (u=0.85), both growth curves began an asymptotic phase. During the last experimental week, BW and EBW reached a maturity degree of 0.92. Bone had an earlier development than muscular tissue. In both cases maximum AGR was achived between the 5th and 6th weeks of age with maturity degree values of bone and muscular tissues of 0.36 and 0.24 respectively. Asymptotic phase of bone began at 14 weeks of age (u=0.88). On the other hand, relative to the muscular tissue it began at 17 weeks of age (u=0.79). From this moment, both tissues showed a similar trend. At the end of this period, bone development was nearly finished (u=0.99) and muscular tissue reached a maturity degree of only 0.92.

CRECIMIENTO CUANTITATIVO DEL TEJIDO MUSCULAR Y OSEO EN EL CONEJO DE CARNE

Se utilizaron 100 conejas de una línea sintética, en un diseño "cros-sectional". Los animales se sacrificaron a intervalos semanales entre 1 y 25 semanas de edad. El peso vivo vacío (PVV) se calculó eliminando del peso vivo (PV) el contenido del tubo digestivo y la vejiga de la orina. Se seccionó la cabeza, patas, órganos, tracto gastro-intestinal, piel y depósitos adiposos. Tras 24 horas a 4° C la canal se separó en sus componentes óseos y musculares. Los datos se analizaron con el modelo de Richards, que en trabajos previos mostró el mejor ajuste. A partir de esa ecuación se estudió la evolución del grado de madurez (U), velocidad absoluta (VA) y velocidad relativa (VR). El PV y el PVV siguieron una tendencia similar, alcanzando su máxima VA entre la 5ª y la 6ª semana (U = .24). Ambas curvas inician la fase asintótica a partir de las 20 semanas (U=.85), alcanzando una tasa de madurez de .92 en la última semana de la experiencia. El tejido óseo fue más precoz que el tejido muscular y la máxima VA se situó entre la 5ª y la 6ª semana en ambos casos, con valores de U de .36 y .24 para el tejido óseo y muscular respectivamente. La fase asintótica en el tejido óseo se inició a las 14 semanas (U=.88) y en el tejido muscular a las 17 (U=.79). A partir de esta edad se observó una evolución paralela de ambos tejidos. Al final del periodo experimental el tejido óseo completó prácticamente su desarrollo y el tejido muscular alcanzó un grado de madurez de .92.