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THE EFFECTS OF RECOMBINANT PORCINE SOMATOTROPIN ON RABBIT GROWTH, FEED EFFICIENCY AND BODY COMPOSITION.

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ABSTRACT

The effects of recombinant porcine somatotropin (rpST) were studied on rabbits from INRA 1077 strain, between the ages of 70 to 90 days. Ten rabbits received a daily intra-muscular rpST injection (100 µg per day per kg of live weight) and were compared with ten control rabbits. Growth rate and feed efficiency were not affected by treatment. Perirenal fat deposits were smaller in rpST treated than in the control rabbits (2.01 *vs* 2.72%); as were carcass lipid content (9.4 *vs* 10.8%) and energy value (8.4 *vs* 8.8 MJ/kg). The ratio between poly-unsaturated fatty acids (FA) and saturated and mono-unsaturated FA was higher (0.32 *vs* 0.28). Carcass protein content was increased (20.5 *vs* 19.9%), as the percentage of skin (14.3 *vs* 13.4% of live weight). Muscular ultimate pH (24 h *post mortem*) was lower in the *semimembranosus accessorius* (5.67 *vs* 5.78) and in the *biceps femoris* (5.65 *vs* 5.74) of treated rabbits. In conclusion, rpST, as a heterologous hormone, develops protein-rich tissues whilst lowering fat content and appears to affect the balance of muscular energy metabolism.

KEYWORDS

Recombinant porcine somatotropin, rabbit, growth, feed efficiency, body composition, meat, technological qualities.

INTRODUCTION

In the pig, recombinant porcine somatotropin (rpST) increases growth rate and feed efficiency. It lowers carcass fat and promotes muscular growth. The effects of rpST on muscular biology and on technological meat quality are not well established as yet (Bonneau, 1990). Somatotropin appears to have interest in meat rabbit production, especially when the aim is to obtain heavy carcasses through longer fattening periods. The hormone should limit the adipogenesis when relative growth rate of adipose tissue is fast (Cantier et al., 1969). However rabbit recombinant somatotropin is unavailable. The growth hormone of pig pituitary extracts has been generally shown to promote lipolytic activity (Vézinhet et al.,1972; Vézinhet, 1973; Vézinhet et Dulor, 1976; Barenton et al., 1984) and proteinogenic activity in rabbit (Reeds et al., 1971; Turner et al., 1976). This should be due to physico-chemical similarities between porcine and rabbit somatotropin (Dulor, 1984). Therefore, rpST is likely to be active in the rabbit. Our study aims to test this hypothesis.

MATERIAL AND METHODS.

Experimental animals and conditions.

The experiment was carried out with male rabbits from INRA 1077 strain of New Zealand breed origin. The rabbits were weaned at 30 days and caged for fattening in groups (16 per m^2) until 70 days. Then, twenty rabbits (live weight: 2099 ± 169 g) were divided into two groups of ten rabbits of similar weight and caged singly. One group was treated with rpST for 18 days; the rabbits received, between 9.00 to 10.00 a.m., a daily 0.5 ml intra-muscular injection (*longissimus dorsi* muscle) of an aqueous solution of sodium bicarbonate (6.3 g/l) containing 45 mg of rpST per 100 ml, thus on average about 105 µg of rpST per day and per kg initial live weight. Differences in weight between the rabbits were not taken into account. The other rabbits made up the control group, which were given injections of aqueous solution in the same quantities. All the rabbits were slaughtered at 90 days, 3 days after the last injection. From the time of weaning to 70 days, and during the experimental period, the rabbits were given *ad libitum* a balanced diet. The feed contained 16.7% crude protein, 16.4% cellulose (Weende) and 11.28 MJ digestible energy per kg.

Analysis of characteristics

Analyses were carried out on characteristics of growth and feed intake, slaughter yield components, anatomical and chemical carcass composition, technological meat variables. The choice of descriptive carcass characteristics conforms to the recommendations laid down by Blasco, Ouhayoun et Masoero (1990).

Growth and feed consumption variables

Live weight at the beginning of rpST treatment (LW70) and at 90 d (LW90), average daily gain (ADG) and feed consumption (ADC), ratio of feed consumption to weight gain (CI) between 70 and 90 d.

Dressing percentage components

Slaughter weight at 90 d (SW90). Commercial carcass weight (CCW). Expressed in percentage of SW90: weight of skin (SkP), full (FGTP) and empty (EGTP) gastro-intestinal tract, commercial carcass weight (CDP). Expressed in percentage of CCW: drip loss of commercial carcass during chilling (24 h, 0-4°C) (DLP).

Anatomical and chemical body composition variables

Expressed in percentage of CCW: weight of liver (LvP) and kidneys (KiP). Reference carcass weight (commercial carcass without head, liver, kidneys and the set of organs of neck and chest) (RCW). Hindleg weight (HLW). Hindleg muscle/bone ratio (HL M/B); thigh-bone length (TBL). Expressed in percentage of RCW: weight of hindleg (HLP), weight of perirenal (PFaP) and interscapular fat deposits (SFaP), weight of water (WaP), proteins (PrP), lipids (LiP) and ash (AsP), gross energy (EnP). The chemical analysis of reference carcass were carried out on matter ground at liquid nitrogen temperature (Dangoumau grinder). Water and ash contents were determined through dessication for 24 h at 103°C followed by incineration for 6 h at 530°C. Measurements of protein content (N x 6.25) (Technicon, 1969) and energy values (adiabatic calorimeter) were made on freeze-dried matter. Lipid content was estimated according to the following equation :

$$\text{Total energy (MJ/100g)} = (3.766\ \text{LiP} + 2.385\ \text{PrP}) / 100,$$

where 3.766 and 2.385 are the energy values (MJ/100g) of lipids and proteins, respectively. Lipids from perirenal fat deposits were extracted by the Folch et al. (1957) method. Their total fatty acid composition was determined by gas chromatography of methyl esters.

Technological meat variables

Expressed in percentage of hindleg weight (HLW): cooking loss (HL CLP). Muscular ultimate pH (24 h *post mortem*) of three muscles of the thigh: *semimembranosus accessorius* (pHu SMA), *biceps femoris* (pHu BFE) and *tensor fasciae latae* (pHu TFL).

Statistical analysis

A covariance analysis was carried out with the Harvey software package LSMLMW (1987) using the following linear model (1):

$$Y_{ij} = \mu + A_i + b_i x_{ij} + e_{ij}$$

where :

Y_{ij} : value of the variable concerning the j^{th} subject at the i^{th} stage of treatment,
μ : general average of the variable,
A_i : fixed effect of treatment,
b_i : regression coefficient of the variable in relation to initial live weight, by modality of treatment,
X_{ij} : value of co-variable in the j^{th} subject at the i^{th} stage of treatment,
e_{ij} : random residual effect.

RESULTS AND DISCUSSION

Since linear regression coefficients in relation to initial live weight do not differ significantly between treatments (absence of interaction), they are not given in the tables of results. These show average results estimated by means of the above model (1) for both groups, and the probability of significance of the linear regression coefficient in relation to the co-variable. The regression analysis shows significant links between initial live weight and ponderable variables. Generally, the higher is initial live weight (co-variable LW70), the higher are final live weight (LW90), slaughter weight (SW90) and these components: commercial carcass weight (CCW), reference carcass weight (RCW) and hindleg weight (HLW) (P < 0,001***). As are feed index (CI) (P = 0,050**) and interscapular fat percentage (P = 0,087*).

Growth and feed intake (table 1)

The hormonal treatment does not influence feed intake (ADC) nor growth rate (ADG) and feed index (CI). *A priori*, the heterologous pST is not active in the rabbit. Indeed, in the pig, a decrease of feed consumption is the first effect observed of treatment (Bonneau, 1990).

Slaughter yield components (table 2)

Although the hormonal treatment does not affect slaughter weight (SW90), it produces a significant increase in skin percentage (SkP): the relative difference between the treated and control rabbits is about 7%. Such a result has been already pointed out in the pig (Bonneau et al., 1989; Beerman et al., 1990). However, slaughter yield (CDP) is not lowered by rpST treatment since the full gastro-intestinal tract (FGTP) is relatively (though not significantly) lighter (P = 0.28). Water loss during chilling (DLP) is the same in both groups.

Anatomical and chemical carcass composition (table 3)

The rpST treatment reduces the adiposity of reference carcass (RCW), but to a different extent according to anatomical area. Interscapular adipose tissue (SFaP) is not significantly reduced (P = 0.17). Perirenal fat (PFaP), which develops relatively later than interscapular fat (Vézinhet et Prud'hon, 1975), is strongly affected by the treatment: it is significantly lower in the rpST group (- 26%). The treatment also tends to increase the muscle/bone ratio (HL M/B) (P = 0.17) in the hindleg. However, the length of thigh bone (TBL) is not affected. This absence of effect on skeleton is probably related to the fact that relative growth rate of bone is too slow (Cantier et al., 1969) at the stage chosen for the treatment. Liver (LvP) and kidney (KiP) proportions do not differ between the two groups. The reference carcass of the rpST rabbits has a higher water (WaP) and protein (PrP) content, but a lower energy (EnP) and lipid (LiP) content than that of the control group. The proportion of polyunsaturated fatty acids (FA) in perirenal fat is higher in the rpST rabbits. Consequently, the ratio of polyunsaturated to saturated and monosaturated FA is increased to an appreciable extent (0.32 *vs* 0.28) (table 4). A comparable effect on fatty acid composition of rpST treatment has been observed in pigs (Mourot et al., 1992); it may be attributed to the fact that the endogenous saturated and monounsaturated fatty acids are diluted by the polyunsaturated fatty acids carried out by feed, as rpST slows down synthesis of the former.

Technological meat characteristics (table 5)

Ultimate pH (pHu) in the *semimembranosus accessorius* (SMA) and *biceps femoris* (BFE) muscles is significantly more acid in rabbits treated with rpST. The *tensor fasciae latae* muscle (TFL), which energy metabolism is relatively more oxydative and ultimate pH relatively higher (Delmas et Ouhayoun, 1990), is not affected by the treatment. Differences in ultimate pH between the two groups are moderate and do not determine any difference in cooking loss of hindleg meat (HL CLP). The lower ultimate pH observed in white muscles resulting from rpST treatment, which may be attributed to a higher capacity for anaerobic metabolism, does not concord with all observations made in pig (Fabry et al., 1991; Mourot et al., 1992).

CONCLUSION

This study shows that recombinant porcine somatotropin is active in the rabbit. A reduction in carcass adiposity was expected, on the basis of results from experiments in pig and on the fact that, in the rabbit, at the stage chosen for the experiment, relative growth rate of adipose tissue is very fast. Such is the case. A decrease in carcass lipid content occurs together with an increase in lipid polyunsaturation. Treatment also appears to improve proteinogenesis: skin proportion and nitrogen content of the carcass are increased, musculature tends to be relatively more developed. All protein-rich tissues are improved to the detriment of fatty tissues. However, the effects are less apparent than in pig. They are not linked with an improvement of feed efficiency. The effects of rpST over several different stages of growth should be studied with variable doses, in order to test all the assumed effects of the heterologous hormone rpST on the rabbit.

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Table 1. Growth performances and feed consumption

		Treatment (T)		Probability		Error mean square
		rpST	control	T	b(1)	
Rabbit	no	10	10			
LW70	g	2100	2099	0.992		30132.0
LW90	g	2603	2608	0.920	< 0.001***	15326.2
ADG	g/d	25.2	25.5	0.923	0.308	38.43
ADC	g/d	149.4	156.3	0.392	0.268	302.8
CI		6.21	6.37	0.751	0.050**	1.27

*** P < 0.01; ** P < 0.05; * P < 0.10
(1) probability of significance of linear regression coefficient

Table 2. Slaughtering measurements

		Treatment (T)		Probability		Error mean square
		rpST	control	T	b(1)	
SW90	g	2593	2591	0.976	< 0.001***	14292.6
CCW	g	1560	1556	0.921	0.001***	6919.1
SkP	% SW90	14.3	13.4	0.042**	0.317	0.81
FGTP	"	16.7	17.4	0.281	0.230	2.04
EGTP	"	7.7	7.8	0.591	0.146	0.24
CDP	"	60.2	60.1	0.846	0.354	2.23
DLP	% CCW	2.0	2.1	0.106	0.587	0.01

*** P < 0.01; ** P < 0.05; * P < 0.10
(1) probability of significance of linear regression coefficient

Table 3. Anatomical and chemical components of carcass

		Treatment (T)		Probability		Error mean square
		rpST	control	T	b(1)	
LvP	% CCW	5.85	6.36	0.288	0.706	1.08
KiP	"	1.01	1.01	0.999	0.761	0.01
RCW	g	1288	1275	0.680	< 0.001***	4410.4
HLW	g	210.4	205.8	0.203	< 0.001***	59.89
HL M/B		6.84	6.59	0.170	0.941	0.16
TBL	cm	9.49	9.44	0.573	0.042	0.04
HLP	% RCW	32.7	32.3	0.371	0.126	0.94
PFaP	"	2.01	2.72	0.014**	0.832	0.32
SFaP	"	0.64	0.74	0.171	0.087*	0.02
WaP	% RCW	66.3	65.5	0.102	0.019	1.06
PrP	"	20.5	19.9	0.076*	0.960	0.43
LiP	"	9.4	10.8	0.065*	0.223	2.71
AsP	"	3.5	3.7	0.258	0.640	0.27
EnP	MJ/100g RCW	0.84	0.88	0.088*	0.118	0.26

*** P < 0.01; ** P < 0.05; * P < 0.10
(1) probability of significance of linear regression coefficient

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Table 4. Fatty acid composition (%) of perirenal lipids

Fatty acids (FA)	rpST	control
Capric	0.20	0.15
Lauric	0.30	0.20
Myristic	3.35	3.45
Palmitic	29.25	28.30
Stearic	5.35	5.80
Saturated FA (S)	38.45	37.90
Palmitoleic	4.95	5.00
Oleic	31.00	33.80
Monounsaturated FA (M)	35.95	38.80
Linoleic	19.70	18.00
Linolenic	4.30	3.80
Polyunsaturated FA (P)	24.00	21.80
Odd numbered and branched FA	1.55	1.95
P / M+S ratio	0.32	0.28

Table 5. Technological meat qualities

		Treatment (T)		Probability		Error mean square
		rpST	control	T	b(1)	
HL CLP	% HLW	25.0	25.4	0.355	0.923	0.71
pHu SMA		5.67	5.78	0.049**	0.760	0.01
pHu BFE		5.65	5.74	0.095*	0.704	0.01
pHu TFL		5.80	5.78	0.742	0.492	0.01

(1) probability of significance of linear regression coefficient

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