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CROSSBREEDING EXPERIMENT OF NEW ZEALAND WHITE FEMALES WITH WHITE GIANT, PURE AND SYNTHETIC, AND STABILIZED STRAINS, IN CONVENTIONAL OR FASTED PRESLAUGHTER CONDITION.

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I T A L Y

ABSTRACT. - One experiment was carried out in june/1990 with New Zealand W (**N**) does, mated to bucks: White Giant (G); backcrosses (**GN**); Carmagnola Grey (CG) in comparison to **N** and commercial hybrid Elco (E) crosstransferred to **N** does at 1 day. The diet (12.2 Mj_DE/kg_DM; 11.1 g_Dig_prot/Mj_DE; CUD_ODM 68.3%; Dig_Prot 13.6%; Dig_Fibre 4.2%; Indigestible_Fibre 10.9%) was offered ad libitum from 35 to 83 days of age. **E** kits were 9 % heavier at 35 d. Final LW was 2581 g in **N** and a significative prevalence was recorded for G (10.8%) and **GN** (5.3%). The ADG ranked the sires in the same pattern, but over differentiated the heavier types (18.6 and 10.6 %, G and **GN** origin respectively). Not significant differences in feed intake were present, this fact implying correlative intrinsic varied efficiencies, but **GN** progenies were slightly hyperphagy (due to negative non additive genetic effects) and the improvement of FCI, vs **N**, was -11.9 and -5.1%. The slaughtering (#73) was preceded by a solid 24 h fast in one half of the subjects.
Genetic groups interacted significantly with fasting factor only in last-day weight change. On the average the G group showed high skin and head %, low blood % . The CG progenies were characterized by two aspects: high amount of fat depots, only in the periscapular site, and high muscular pH_24_h values . The synthetic **GN** group showed some non additive segregations, even in somatic traits.
Key Words: Rabbits, Breed Differences, Genetic effects, Crossbreeding, Carcass Quality, Preslaughter Fasting.

Introduction

Crossbreeding is largely diffused in intensive rabbit production system. Performances and characteristics of the existing breeds and of specific stabilized strains , however, were not comprehensively investigated (Afifi and Kahlil, 1990; Rouvier, 1991; Baselga and Blasco, 1989). From a review of many european works (Masoero, 1991) it was enhanced the interest in the use of a mass factor in order to increase production and efficiency. Heavy types are normally used in terminal crossing of chickens, or turkeys. The use of Giant purebred rabbits for terminal crossing was envisaged by Ozimba and Lukefhar (1991), but it is not yet widely diffused because it was somewhat criticized for reproductive traits and livability of kits (David et al., 1990; Cavalletti et al., 1991). The use of half-breed bucks outcoming from a giant grand-parent was an attempt to reduce fitness problems (Masoero et al., 1991). Reproduction and stabilization of synthetic two-breeds for terminal crossing may be a way to get complementary traits together, but some further knowledges about specific non additive genetic effects like direct

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heterosis and recombination losses are very suitable in order to stabilize the chief traits in the final product, as well as in the breeded stock.
The objectives of this study were to evaluate conventional purebreds and terminal crossbred groups of rabbits. As a candidate sire group it was comprised in experiment the Carmagnola Grey, a stabilized strain (Zoccarato et al, 1990) to be evaluated for live and carcass traits. It was also included in experiment a sample of widespread commercial hybrids. Finally, the Giant White pure and their half-breeded synthetic progeny bucks were raised and studied.

Material and Methods

Animals and raising. The experiment was carried out in june/1990 with New Zealand White (N) does, mated to White Giant (G), to backcrosses (GN) to Carmagnola Grey (CG) bucks (with a minimum of 4). The crossbred progenies were compared to a lot of purebred N and to a lot of commercial hybrid Elco (E): the 1-day kits were crosstransferred to N does into the experimental herd. After weaning at 28 days, a commercial diet was offered ad libitum, to the 73 kits placed in single cages. A digestibilty trial was builded with 12 sampled rabbits from the groups. The realized CUD of the organic matter was 68.3% , thus the nutrients of DM were: Dig_Prot 13.6%; Dig_Fibre 4.2%; Indigestible_Fibre 10.9%; DE 12.2 Mj; 11.1 g_Dig_prot/Mj_DE. The on live trial with individual feed recording started at 35 and ended at 83 days of age, when one half of the subjects were solid fasted for a 24_h duration. The rabbits were stunned and bleeded. The body components and the carcass dissection were executed according to Blasco et al. (1991).

Genetic model and statistical analyses. A one way fixed effects linear model was adapted to live data:

$$Y_{ij} = m + SIRE\_GROUP_i + E_{ij} \quad (i=1 \text{ to } 5).$$
$$[Y_{ik} = m + A_i + E_{ik} \quad \text{-Model I}]$$

where i=1 (NZW = N); 2 (Giant White = G); 3 (ELCO hybrids = E); 4 (Carmagnola Grey = CG) 5 (backcross to N does = GN).
A two way fixed effects linear model was adapted to slaughtering and carcass variables expressed both as weights (non covariated) and as percentages of the major component (LW or CCW).

$$Y_{ijk} = m + SIRE\_GROUP_i + COD\_FASTING_j + INTERACTION_{ij} + E_{ijk}$$
$$[Y_{ijk} = m + A_i + B_j + A \times B_{ij} + E_{ijk} - \text{Model II}]$$

where j=1 (Conventional, not fasted); =2 (Fasted 24 h)
The Proc GLM of the SAS System (SAS, 1987) was then used on PC.
From a genetic outline, in the case of F1 crossing, the LS estimates represent 1/2 of the two parental breeds ± the heterosis effects, which are not strictly and separately estimables when one parental group is missing : this was the case of the Carmagnola Grey. Then the difference from the N purebred, chosen as reference group, included all the heterotic effects.
In the more complete case of progenies sired from White Giant (G) purebred and progenies sired from the synthetic GN buck the underlying genetic model can be amplified. According to Dickerson (1969), when a F2 group is added, another important genetic source of variation is included: the recombination effects. The table 1 explains the effects involved and how these were solved reducing the heterosis (h_) by confounding them with additive G (a_G) in a relative ratio K (h_/a_G) [Model III]. The recombination parameter remains invariant in respect to K, and it is correctly estimable as two times the F2 minus the parental and minus the F1.

Table 1. - Matrices of the direct effects involved in the subexperiment and formulas for computing.

1.1 -Incidence matrix

Group	Matinmean	a_N	a_G	h_	r_
G GxN	1	0.5	0.5	1	0
GN GNxN	1	0.75	0.25	0.5	0.5
N NxN	1	1	0	0	0

1.2 Reduced matrix confounding Additive_G and heterosis in a ratio K

	mean	a_N	a_G(h_)	r_
G	1	-0.5	0.50*(1+k)	0
GN	1	-0.2	0.25*(1+k)	0.5
N	1	0	0	0
constraint	0	1	0	0

1.3 -Inverse of 1.2 in the case k= h_/a_G = 20%

mean	0	0	1	0
a_N	0	0	0	1
a_G(h_20)	1.67	0	-1.67	0.83
r_	-1	2	-1	0
	g r o u p			
effects	G	GN	N	

a_ : additive effects; h_ : individual heterosis effects;
r_ : individual recombination effects.
SAS Statement in proc GLM (SAS, 1987) used in estimation and testing.
ESTIMATE "a_G+h_ " INTERCEPT 0 GROUP 5 0 -5 / DIVISOR=3; (if k=0.20).
ESTIMATE "r_ "INTERCEPT 0 GROUP -1 2 -1 ;
this estimate is invariant to K.

Results and Discussion

Growth, somatic and qualitative traits of the Giant's progenies.
The postweaning growth potential of White Giant bucks was fully displayed on trial (Table 2). Final LW was 2581 g in **N** and a significative prevalence was recorded for **G** (10.8%) and **GN** (5.3%). The ADG of **G** was increased of 18.6% while **GN** was ranked 10.6% over the **N**. It must be remarked that the control grew only 30.8 g/d. Thus genetic differential accounting for an hypothetic 20% of heterosis should have been near 10 grams per day.

No significant recombination was tested in the F2 bucks and an additive determinism can be invoked for this main trait. Cavalletti et al (1991) tried only +8% by crossing Flemish Giants and further (recalculated) +5% from recombinative effects with backcrossed bucks. In previous trials (Masoero et al., 1991) a strong negative trend for recombination appeared for Flemish Giant and Checkered Giant, but not for Vien Blue crossed with NZW or Californian.
As a consequence of similar preweaning growth the livebody weight at 83 d was increased of some 300 grams in **G** and 200 grams in the **GN** progenies.

Table 2.- Growth and slaughtering traits Sire Group Means, significance of factors (A,B,AxB) , differential effects of fasting (F-C), and estimates of the genetic effects additive (as function of heterosis =20%) and recombination (r_) in the N, G and GN groups.

S I R E		G R O U P S		F-C signif.			a_G(h)_	r_	RSD
N	G	E	CG	GN					
## C F	C F	C F	C F	C F	P(A	P(B)	P(AB)			
15	15	15	14	14						
Live Weight 35_d						np	np	4	-58	83.6
956 b	959 b	1038 a	959 b	928 b	**					
Live Weight 83_d				-48		np	np	465**	-8	252
2581 b	2861 a	2641 b	2647 b	2717 ab	*					
Average Daily Gain						np	np	9.6***	0.8	4.8
30.8 c	36.6 a	30.3 c	31.8 bc	34.1 ab	***					
Average Feed Intake						np	np	13.6+	7	13.5
118.7	126.8	121.	124.6	126.3						
Feed Conversion Index						np	np	-0.78**	0.06	0.50
3.95 b	3.48 a	4.05 b	3.94 b	3.75 ab	**					
Last day Body Variation, Weight						-185				
26 -91	60 -167	48 -188	28 -164	11	**	***	*	- 34	-48	55
-33	-53	-70	-68	-67						
Last day Body Variation, Percentage						-6.7				
1.0 -3	2.1 -6	1.8 -7	1.0 -5.9	0.5	**	***	*	-0.9	-1.2	1.8
-1.3	-1.9	-2.6	-2.5	-2.2						
Slaughter Weight						-179				
2546 b	2820 a	2610 b	2639 b	2721 ab	*	***		457**	76	229
Hot Commercial Dressing Percentage						2.14				
61.3	60.8	60.9	61.4	60.5		***		-0.8	-1.1	1.8
Cold Commercial Dressing Percentage						2.03				
58.6	57.8	58.3	58.9	58.0		***		-1.3	-0.4	1.8
Gastrointestinal Tract & Gut Weight						-115				
410	452	447	425	429		***		69	-5	5.4
Gastrointestinal Tract & Gut Percent						-3.2				
16.1	16.0	17.1	16.1	15.9		***		-0.3	-0.4	0.19
Blood percentage						0.07				
3.2 ab	3.0 c	3.1 bc	3.4 a	3.4 ab	***			-0.4*	0.5*	0.31
Commercial Skin Weight						-17				
360 ab	401 a	352 b	388 a	405 a	**			69*	48+	50
Commercial Skin Percentage						0.3				
14.0 ab	14.2 ab	13.5 b	14.7 a	14.8 a	**			0.3	1.4*	1.1

fasting C=Conventional, F=Fasted; +P<0.10; *P<0.05; **P<0.01;
***P<0.001; np = not performed.

Table 3.- Carcass traits. Sire Group Means, significance of factors (A,B,AxB) , differential effects of fasting (F-C), and estimates of the genetic effects additive + heterosis (a_G(h=20%)) and recombination (r_) in the N, G and GN groups.

SIRE GROUPS						F-C signif.			a_G(h)	r_	RSD
N	G	E	CG	GN		P(A)	P(B)	P(AB)			
Liver Weight							-27				
73.4 b	87.2 a	75.8 ab	82.8 ab	76.3 ab			***		23*	-8	1.68
Liver Percentage							-1.85				
5.48	6.02	5.53	5.95	5.40			***		0.9	-0.7	0.11
Hearth lungs percentage							-0.14				
2.45 a	2.48 a	2.45 a	2.39 ab	2.14 b					0	-0.6*	0.04
Perirenal Fat Weight							-2.3				
21.52	25.64	25.1	27.29	25.6					7	4	0.97
Perirenal Fat Percentage							-0.15				
1.56	1.75	1.82	1.95	1.77					0.3	0.2	0.06
Periscapular Fat Weight							-1.2				
8.65 b	9.36 b	10.5 b	14.53 a	11.01 b	***				1.0	4+	0.38
Periscapular Fat Percentage							-0.08				
0.63 b	0.64 b	0.76 b	1.04 a	0.77 b	***				0	0.27+	0.02
Kidneys Weight							-1.4				
14.82 c	17.18 a	*****bc	15.88 abc	16.36 ab	*		**		3.9**	0.7	0.20
Kidneys Percentage							-0.09				
1.11	1.18	1.15	1.15	1.15			**		0.12	0.1	0.01
Head Weight							-3				
121.4 c	149.1 a	129 b	129 b	127.8 bc	***				46***	-15**	9.67
Head Percentage							-0.09				
9.09 bc	10.27 a	9.50 b	9.39 bc	9.02 c	***				1.9***	-1.3**	0.64
Reference Cold Carcass Weight							-15				
1342 a	1453 b	1362 ab	1382 ab	1423 ab					186*	49	137
pH24_T7							0.06				
6.22 ab	6.05 c	6.11 bc	6.30 a	6.08 bc	*				-0.29*	-0.1	0.23
pH24_L6							0.065				
5.96 ab	5.84 ab	5.96 b	6.06 a	5.82 b					-0.21	-0.16	0.25
Atlas-L7 Lenght							-0.54				
28.9 b	30.3 a	29.0 b	29.4 b	29.5 b	***		**		2.38***	-0.22	0.83
L7_Ischion Length							-0.13				
7.5 c	8.5 a	7.9 b	7.7 bc	7.9 b	***				1.68**	-0.2	0.28
Carcass Loin Circumference							0.10				
17.8 b	18.7 a	17.8 b	18.4 bc	18.1 bc	*				1.52**	-0.14	0.95

+P<0.10; *P<0.05; **P<0.01; ***P<0.001.

The feed intake did not show relevant differences in absolute. Reported to the respective averages as unit of metabolic weight **N** and **G** progenies were alike (0.435 and 0.438 g/d,gMW), while the progeny of **GN** bucks (0.452 g/d,gMW) displayed a tendency to the hyperfagy because non additive effects. This excess of nutrients favoured correlative early lipid deposition in the periscapular site (recombinative effects =+0.27, equivalent to +42% vs **N**:, P<0.10; table 3).
Feed efficiency of **G** progenies in the constant age interval was improved of 11.9 % (relative); the **GN** progenies confirmed good additively for this trait. The more juvenile status connected to Giant presence did not present less deposition of fat. Reduction of perirenal fatness was previously reported : 1.56 vs 2.27 for **N** (Ozimba and Lukefahr, 1991); 1.4 vs 2.1 (Masoero, 1992). Otherwise David et al. (1990) did not observe reduction in adiposity by crossing with Flemish Giant. In the present case the growth of the **N** group was poor (only 30.8 g/d) and the genetic differential in fatness was limited.
In four somatic traits additively transmission was infirmed:

- -first, in the heart plus lung percentage the recombinations were strong (-0.6 grams, that is equivalent to -24%);
- -second, the head weight and percentage, which were increased by crossing, otherwise were strongly reduced in the F2 individuals : estimated recombination rate were -15 g (-12.3%) and -1.3% (-14.3%) vs **N**;
- -third, blood % was reduced of 0.4% (12.5% relative) by additive G and increased of 0.5% (15.6% relative) by a recombinative effect;
- -fourth, the commercial skin % was also increased in the **GN** progenies due to a recombination of 1.4% (+10% relative).

No effects concerned dressing percentage, gastro-intestinal tract , and this may be also a result. Somatic measurements emphasized adult size differential: giant's progenies were long and deep, thus greatly appreciable for medium or heavy products.
Quality of muscle was slightly differentiated by genetic additive factors: the estimates were -0.29 (*) and -0.21 units in the pH of Long. dorsi thoracicus and lumbarum. In the crossbred groups the meat from Giant descent tended to be a little more acid than **N** purebred: thus "a priori" quality of their cooked meat can be superior.

Growth, somatic and qualitative traits of Carmagnola grey and ELCO hybrid. Both this groups were similar to **N**. Nevertheless the stabilized Carmagnola grey strain showed higher fatness in the periscapular site as well as an higher final pH value of the muscle. A direct panel test was not realized, but higher pH, without fasting effects (Masoero et al.,1992, a) should indicate less preferability. When the panel was realized with purebreds (Masoero et al., 1992,b) a negative (n.s.) trend was observed.
The ELCO sample tested showed a lighter skin developpement, both as weight and as percentage (13.5 vs 14 vs **N**).

Effects of preslaughter fasting. Significant and clear effects regarded many traits: the slaughter weight was decreased of 179 grams; the dressing percentage was raised of 2.03% due to a reduction in gut contents (-115 g) which over-compensated the reduction in cold carcass (about 40 grams), due to liver (-27 g), kidneys (-1.4 g) and true body mass (-15 g). Fasting effects confirm the main results from a specific work (Masoero et al., 1992 a), except the lowering of muscle pH.
Interaction of genetic group with fasting was displayed only in the weight

change during the last day (table 2): it can observed very different patterns of variation in the livebodyweights; this may be due to unpredictable effects of factors connected to the many stresses (handling, weighting, removing feeders...) which noise to the animals in the last day of experiment.

Conclusions

The combinability of G with **N** was excellent: the mass was increased at a lower feeding cost. Dressing percentage was not penalized from offal (except the head) and the resulting carcass was heavy, long and deep and lean. This crossing may be used to produce medium-heavy carcasses, probably with energetic diets without danger of overfatness. Meat quality was a priori improved because genetic descending of muscular pH. Utilisation of backrossed bucks thus was convenable because the determinism of main traits was additive, but significant deviations were observed in recombinant backcrosses **GN** progenies. These were decreasing for head weight and percentage and for heart plus lungs, while increasing for blood percentage and periscapular fat percentage. Foundation of a synthetic strain **GN** can be pursuited, aiming to determine litter size implications in production as well as in selection.
The commercial hybrids tested and the Carmagnola grey stabilized strain were belowe the White Giant descend, being in fact very similar to the **N** purebred for direct productive effects.

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