EFFECT OF DIVERGENT SELECTION BASED ON CT MEASURED HIND LEG MUSCLE VOLUME ON PRODUCTIVE AND CARCASS TRAITS OF RABBITS

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ABSTRACT

Rabbits were divergently selected for muscle content on hind legs, as measured by computerized tomography (CT). Progenies of does and bucks in the first and second generations were compared: M=progenies of minus selected parents of the first generation (n=71), P=progenies of plus selected parents of the first generation (n=64), MM=progenies of minus selected parents of the second generation (n=25), PP=progenies of the plus selected parents of the second generation (n=57). Forty 10-week old rabbits in the M and P groups and 24 animals in the MM and PP groups were scanned by CT and their muscle volume of their legs was measured. All these rabbits were slaughtered and the carcasses were dissected. In the progenies of the first generation the production was similar, but in the progenies of the second generation the feed intake (128 vs. 138 g/d, P<0.001) and feed conversion ratio (2.81 vs. 3.01 g/g, P<0.001) were better in PP than in MM groups; body weight and weight gain were similar. Significant differences were found in the progenies of the first generation: weight of skin, kidneys and periscapular fat was higher in M group, while the weight of hind part of carcass was higher in P group. Proportion of fat deposits and that of mid part to reference carcass were higher in M rabbits, while the proportion of hind part was higher in the P group. More pronounced differences were found in the progenies of the second generation: the weight of perirenal (29.4 vs. 23.8 g, P<0.05) and periscapular fat (6.05 vs. 13.0 g, P<0.001) was lower, while the weight of the hind part (473 vs. 439 g, P<0.05) and hind legs (355 vs. 326 g, P<0.05) was higher in PP rabbits. The proportion of gastrointestinal tract to body weight was lower in PP group (16.7 vs. 18.1%, P<0.05). Significantly lower proportion of perirenal and periscapular fat and fore part of carcass (1.90 vs. 2.40%, P<0.01; 0.49 vs. 1.07 g, P<0.001; 29.4 vs. 30.1%, P<0.05, respectively), while higher proportion of hind part and hind legs to reference carcass (38.2 vs. 36.3%, 28.7 vs. 26.9%, P<0.001, respectively) were measured in PP group compared to MM rabbits. Results of the experiment give some evidence for effectiveness of CT based selection. If the selection objective is to increase the volume of hind leg muscles, not only the carcass traits but also the feed intake and feed conversion ratio will improve.

Key words: Rabbit, Divergent selection, Computer tomography, Carcass traits.

INTRODUCTION

Selection for improving the carcass traits of Pannon White rabbits has been carried out for more than 10 years. Carcass traits can be estimated by the CT (Computer Tomography) measured cross-sectional area of *m. Longissimus dorsi* (L-value) (Szendrő *et al.*, 1992). Efficiency of CT selection was proven by divergent selection (Szendrő *et al*., 2005) as well as by Bayesian method (Nagy *et al*., 2006). Comparing with different crossbred rabbits the progenies of Pannon White bucks had the highest dressing out percentage as well as the highest weight and ratio of mid part and *m. Longissimus dorsi* (Metzger *et al*., 2006). In spite of convincing results, in 2005 the selection criterion of CT selection was changed from L-value to hind leg muscle volume. The new generation of CT instrument (spiral CT) is more effective (taking slides at higher speed) thus the time of the examination (and its cost) is lower. This makes possible to take more scans within the same time. At the other hand the volume of

muscle on hind legs is more than double than that of the *m. Longissimus dorsi*. So if the effectiveness of the new method is similar to what was found in *m. Longissimus dorsi* the muscle volume in the body could be increased more.

The aim of this experiment was to study the influence of divergent selection based on the volume of hind leg muscle on production and carcass traits of growing rabbits.

MATERIALS AND METHODS

Animals

Experiment was carried out at the rabbit farm of the Kaposvár University on Pannon White rabbits. One part of the population was divergently selected (positive, negative) on the basis of CT measured hind leg muscle volume. The volume of hind leg muscle was estimated with the help of CT scans taken every 10 mm between *crista iliaca* of *os ilium* and patella. Depending on the dimension of hind legs 11-12 scans were taken. Voxel frequency of density range belonged to muscle tissue (between +20 and +200 of HU scale) was determined in each scan. Summing these values (of 11-12 scans) the volume of hind leg muscle can be estimated. The correlation between CT estimated hind leg muscle volume and hind part, hind legs, thighs and hind leg meat was found to be 0.6-0.7 (unpublished data). Regressing the weight of the hind leg muscle on body weight the rabbits showing the highest positive and negative residuals were selected. Percentages of minus- and plus-selected rabbits from those were taken to CT measurements in each generation are shown in Table 1.

Table 1: Percentage of minus- and plus-selected rabbits in each generation

	1st generation		2nd generation	
	Males	Females	Males	Females
Minus-selected (%)	15	23	17	15
Plus-selected (%)	19	25	11	12

Plus or minus selected does of the first and second generations were mated with similarly selected bucks at the same time. Thus, four groups of kits were born:

M: progenies of the minus-selected parents of the first generation (n=71)
P: progenies of the plus-selected parents of the first generation (n=64)
MM: progenies of the minus-selected parents of the second generation (n=25)
PP: progenies of the plus-selected parents of the second generation (n=57)

Housing and nutrition

Kits were weaned at 5 weeks of age then housed in fattening cages (40x40x35cm) by groups of two. Temperature was 15-16°C and the lighting was 16 h. Until 8 weeks of age rabbits consumed medicated (DE: 10.3 MJ/kg, crude protein: 14.5%, crude fibre: 17.5%, crude fat: 2.00%, Tiamulin: 50 ppm, Diclazuril: 1 ppm, Bacitracin: 200 ppm), and then non-medicated diet (DE: 10.6 MJ/kg, crude protein: 16.0%, crude fibre: 16.0%, crude fat: 3.00%) *ad libitum*. Body weight and feed intake were measured weekly, body weight gain and feed conversion ratio were calculated. Mortality was recorded daily.

CT examination

At 10 weeks of age 40-40 rabbits from M and P groups as well as 24-24 from MM and PP groups (selected randomly) were taken to CT examination to the Institute of Diagnostic Imaging and Radiation Oncology of the Kaposvár University. Three rabbits were fixed into a plastic container simultaneously without anaesthesia. Evaluation of the hind leg muscle volume was the same as described above.

Slaughtering and dissection procedure

After CT examination rabbits were slaughtered and dissected according to the recommendations of WRSA (Blasco and Ouhayoun, 1996). Rabbits were weighed before slaughter then were bled after electric stunning. Carcasses were measured (with head, heart, lungs, liver, kidneys, periscapular and perirenal fat) then placed in a cooling room at 4 ^{o}C for 24 hours. The chilled carcasses were weighed again then heart, lungs, liver, kidneys, pericapular and perirenal fat were removed and weighed. The head was separated and the carcass was split between the 7th and 8th thoracic vertebrae and between the 6th and 7th lumbar vertebrae: fore-, mid- and hind parts were obtained. Hind legs were split and weighed then the meat (HL) was removed and weighed. Proportions of organs and carcass parts to body weight at slaughter and to reference carcass (fore-, mid- and hind part with perirenal and periscapular fat) weight were calculated.

Statistical analysis

Data of the two generations were analysed separately using Student's test of SPSS 10.0 programme package (SPSS for Windows, 1999). The only exception was the carcass traits of the progenies of the first generation in which analysis of covariate was applied since the body weight at slaughter differed significantly in the two groups. Slaughter weight was involved into the model as covariate only when the effect of slaughter weight was significant in this case the effect of selection was considered as fix effect.

RESULTS AND DISCUSSION

No difference was found either in the first or in the second generation in the body weight gain or body weight of rabbits (Table 2). Only a slight difference was found in the feed intake and feed consumption of M and P rabbits, while PP group had 7.2% (P<0.001) lower feed intake and 6.6% (P<0.001) better feed conversion ratio compared to MM animals.

Table 2: Effect of divergent selection based on CT measured hind leg muscle volume on productive traits of the progenies of the first and second generations

Traits	Progenies of the 1st generation				Progenies of the 2nd generation			
	M	P	SE	Prob.	MM	PP	SE	Prob.
No of rabbits	71	64	-	-	25	57	-	-
Body weight at 10 weeks (g)	2473	2526	26.2	0.170	2471	2474	38.6	0.953
Body weight gain between 5-10 weeks (g/d)	45.3	46.1	0.58	0.378	44.7	45.7	0.86	0.307
Feed intake between 5-10 weeks (g/d)	133	130	1.19	0.142	138	128	1.77	<0.001
Feed conversion ratio between 5-10 weeks (g/g)	2.90	2.84	0.03	0.181	3.01	2.81	0.04	<0.001

Progenies of parents selected for higher /P, PP/ or lower /M, MM/ volume of hind leg muscle

Carcass traits of the progenies of the first generation than in that of the progenies of the second generation are seen in Table 3.

In the progenies of the first generation significantly lower skin (-4.3%), perirenal- (-12.3%) and periscapular fat (-30.1%) weight, but higher hind part (+2.4%) weight were measured in P rabbits compared to M animals. Proportion of skin to body weight was significantly lower in P group. Proportion of fat depots and mid part to reference carcass was lower, while that of hind part to reference carcass was higher in P rabbits compared to M group.

In the progenies of the second generation no difference was found in the skin weight, while the gastrointestinal tract weight was 6.8% (P<0.1) lower in PP group compared to MM animals. Weight of perirenal- and periscapular fat was 19.0 and 53.5% lower in PP group than in MM rabbits,

respectively. On the contrary, weight of hind part and hind leg meat was 7.7 and 8.9% higher in PP rabbits, respectively. Higher dressing out percentage (P<0.1) and lower proportion of gastrointestinal tract to body weight (P<0.05) were found in PP group. Proportion of fat depots and fore part to reference carcass was significantly lower, while that of hind part and hind leg meat to reference carcass was significantly higher in PP rabbits compared to MM animals.

Table 3: Effect of divergent selection based on CT measured hind leg muscle volume on carcass traits of the progenies of the first and second generations

Traits	Progenies of the 1st generation[1]				Progenies of the 2nd generation			
	M	P	SE	Prob.	MM	PP	SE	Prob.
No of rabbits	40	40			24	24		
CT estimated hind leg muscle volume (cm^3)	332	342	3.02	0.022	309	336	7.67	0.018
Weight (g)								
Body weight at slaughter	2462	2457	22.7	0.004	2454	2445	41.3	0.881
Skin	372	356	3.24	0.001	350	353	7.35	0.741
Gasrointestinal tract	435	435	6.02	0.966	440	410	11.1	0.063
Reference carcass	1247	1258	5.18	0.131	1212	1237	25.8	0.523
Perirenal fat	28.5	25.0	1.08	0.026	29.4	23.8	1.70	0.025
Periscapular fat	11.1	7.76	0.40	<0.001	13.0	6.05	0.82	<0.001
Fore part	368	375	2.36	0.067	365	364	8.02	0.933
Mid part	378	376	2.00	0.530	368	371	8.19	0.794
Hind part	465	476	2.69	0.011	439	473	9.46	0.020
Meat on hind legs	352	357	2.37	0.216	326	355	8.00	0.019
Proportion to body weight (%)								
Skin	14.9	14.2	0.13	<0.001	14.2	14.5	0.19	0.372
Gastrointestinal tract	17.3	17.4	0.23	0.736	18.1	16.7	0.38	0.045
Chilled carcass /Dressing out percentage/	58.9	59.4	0.20	0.114	58.7	59.8	0.39	0.086
Proportion to reference carcass weight (%)								
Perirenal fat	2.27	2.00	0.08	0.024	2.40	1.90	0.12	0.005
Periscapular fat	0.88	0.62	0.04	<0.001	1.07	0.49	0.07	<0.001
Fore part	29.6	29.8	0.14	0.275	30.1	29.4	0.20	0.016
Mid part	30.3	29.9	0.13	0.031	30.3	30.0	0.18	0.221
Hind part	37.3	37.8	0.13	0.021	36.3	38.2	0.22	<0.001
Meat on hind legs	28.3	28.3	0.13	0.878	26.9	28.7	0.18	<0.001

[1]analysis of covariance
Progenies of parents selected for higher /P, PP/ or lower /M, MM/ volume of hind leg muscle

The CT estimated hind leg muscle volume was significantly (P<0.05) higher in P and PP rabbits compared to M and MM, resp. (Table 3). Due to the correlation between CT measured volume and weighed (at slaughter) hind leg muscle, not only the estimated but also the weighed hind leg muscle was significantly (P<0.05) higher in P and PP rabbits compared to M and MM groups, respectively. Thus, the volume of hind leg muscle could be increased with the help of CT based selection. In spite of this, dressing out percentage was only 1.1% (P=0.086) higher in PP rabbits compared to MM group. Proportion of each carcass parts changed differently. In PP animals with the increasing proportion of hind part to reference carcass (+1.9%) the proportion of fore part decreased (-0.7%). Thus, as a result of selection the proportion of hind (meaty) part increased at the expense of the fore (bony) part, which is really advantageous.

Important difference can be found in the weight of fat depots in both generations but especially in the second one. PP rabbits had similar body weight gain but significantly lower feed intake, consequently improved feed conversion ratio compared to MM group. Based on these results it can be established that PP rabbits developed more muscle (meat) than fat from the consumed feed. Feed is better utilized when animals utilize it to develop muscle instead of fat. This is confirmed by the feed conversion ratio of the last week of fattening (at 9-10 weeks) which was 10.8% (P=0.021) better in PP rabbits which developed more muscle into their body. Lower feed intake of PP group explains the lower weight and proportion of gastrointestinal tract.

Results of this experiment show some evidence that the CT based selection on hind leg muscle volume is effective likewise that was the CT based selection on L-value (Romvári, 1996, Szendrő *et al.*, 2005; Nagy *et al.*, 2006). The effectiveness of our method was confirmed by Gyovai *et al.* (2008).

CONCLUSIONS

Data of this experiment confirm the effectiveness of CT based selection on hind leg meat volume. However considerable differences were found only in the progenies of the second generation. Improved muscle development and lower feed intake with better feed conversion ratio show that PP rabbits developed muscle at the expense of fat. Thus, Pannon White rabbits selected on the basis of CT measured hind leg meat volume could be favourable for both the slaughterhouses (more meat) and the producers (lower feed intake) as well as for the environment (lower amount of manure and non-edible gastrointestinal tract). Since the weight of hind leg muscle is 2.3-2.5 times higher than that of *m. Longissimus dorsi*, the improvement of muscle development could be higher even in case of similar progression to that was reached in L-value. According to these results selection should be continued.

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