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Effect of divergent selection for the computer tomography measured thigh muscle volume on productive and carcass traits of growing rabbits

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ABSTRACT

The objective of the study was to analyze the effects of divergent selection for computer tomography (CT) measured thigh muscle volume (VTM) on the production and slaughter performance of growing rabbits. Pannon White rabbits were selected to increase (PP) or decrease (MM) their VTM during two generations. Production and slaughter traits of their offspring (the third generation) were measured for 25 MM and 57 PP and for 24 MM and 24 PP rabbits, respectively. Selection had no effect on daily weight gain and body weight at 10 week. PP rabbits had lower feed consumption (128 vs. 138 g/d, $P<0.05$) and better feed conversion ratio (FCR) (2.81 vs. 3.01, $P<0.001$) compared to the MM group. CT measured VTM (309 vs. 336 cm^3, $P<0.05$), hind part weight (439 vs. 473 g, $P<0.001$) and meat weight of the hind legs (HLMW) (326 vs. 355 g, $P<0.001$) were higher in the PP group, while the perirenal fat weight (PFaW) (29.4 vs. 23.8 g, $P<0.05$) and the periscapular fat weight (SFaW) (13.0 vs. 6.05 g, $P<0.001$) were lower than that of the MM rabbits. The ratio of the full gastrointestinal tract compared to body weight (GIP) was not higher for the MM rabbits (18.1% vs. 16.7%). Compared to the reference carcass, ratios of the perirenal fat (PFaP) (2.40% vs. 1.90%, $P<0.05$) and periscapular fat (SFaP) (1.07% vs. 0.49%, $P<0.001$) were higher in the MM group while ratios of the hind part (HPP) (36.3% vs. 38.2%, $P<0.001$) and hind leg meat were higher (HLMP) in the PP group (26.9% vs. 28.7%, $P<0.001$). It was thus shown that CT aided selection can efficiently increase the thigh muscle volume. At the same time the volume of fat depots decreased while FCR also improved.

1. Introduction

In rabbit breeding programs, lines are most frequently separated into dam and sire lines. The most common criteria for selection of maternal lines are related to litter size at birth or at weaning and paternal lines for post-weaning body weight gain. Slaughter traits and meat yield of the growing rabbits are important traits, however progeny testing has been practiced only by few researchers (Szendrő et al., 1988; Varewyck et al., 1986) because of its high cost and long generation interval. Economic importance of carcass traits was discussed by Mikó et al. (2010).

Non invasive methods that are suitable to evaluate the carcass traits and meat yields of live animals opened new possibilities in animal breeding. One of these possibilities is the application of computer tomography (CT). A diagnostic center (presently: Institute of Diagnostic Imaging and Radiation Oncology) started operation at Kaposvár University in 1990. Between 1992 and 2003 CT aided selection was practiced improving the cross-sectional muscle area of the *m. longissimus dorsi* (*L-value*) (Nagy et al., 2006; Szendrő et al., 1996). Since 2004 the volume

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of the thigh muscle (*VTM*) has replaced the *L*-value as the selection criterion. Both *L*-value and VTM were selected as a part of a two stage selection program. Only rabbits showing higher daily weight gain (*ADG*) than the average for their kindling batch were selected for the CT measurements (Gyovai et al., 2008). Genetic improvement was estimated in different ways: comparisons were made between Pannon White purebreds and crossbreds including other genotypes (Metzger et al., 2006a,b; Szendrő et al., 2009, 2010), genetic parameters and trends were estimated (Gyovai et al., 2008; Nagy et al., 2006), and divergent selection programs were conducted (Szendrő et al., 1996).

The objective of the present study was to study the effect of divergent CT-aided selection for VTM on the production and slaughter traits.

2. Materials and methods

2.1. Animals and selection criteria

The experiment was carried out following the recommendations for the care and protection of animals used for experimental purpose of the EU (European Union, 2003) at the rabbit farm of the Kaposvár University using Pannon White rabbits. The Pannon White is a synthetic rabbit breed formed by reciprocally crossing several Californian and New Zealand type stocks. After the initial phase, the breed was selected for teat number and ADG between 1990 and 1992, then between 1992 and 2004 the females and males were selected for teat number and ADG, and for ADG and *L*-value, respectively. Since 2004 both sexes have been selected for ADG and VTM. Development and management of the Pannon White rabbit breed is described in detail by Nagy et al. (2010).

In the last period, the experimental population was divergently selected using a two-step selection. First the animals were weighed at 5 and 10 weeks of age. Only rabbits showing higher body weight gain than the average for their kindling batch were selected for the CT measurements. The subsequent CT measurements were carried out in accordance with the reproductive rhythm at every 6th week. The second step of the divergent (positive and negative) selection was conducted on the basis of CT measured VTM. The VTM was estimated with CT scans taken every 10 mm between the *crista iliaca* of the *os ilium* and the patella. Depending on the length of the hind legs, 11–12 scans were taken. Voxel frequency of density range belonging to muscle tissue (between +20 and +200 of the HU scale) was determined in each scan. The VTM was estimated by summing these values (of 11–12 scans). More details about the CT measurements can found in a previous study (Romvári et al., 1996). The VTM was regressed on body weight (BW) and the rabbits showing the highest positive and negative residuals were selected. The breeding animals of the first and second generations were selected based on CT batches 1–10 and 13–15, respectively. The process of the experiment for the first and second generations is presented in Table 1. Only a randomly chosen sample from the third generation progeny was used based on one kindling batch.

Table 1
Process of the experiment in the first two generations.

First generation				
CT scanned female		CT scanned male		
643		214		
Minus selected			Plus selected	
Female	Male		Female	Male
144	29		152	40
Second generation				
CT scanned female		CT scanned male		
117		65		
Minus selected			Plus selected	
Female	Male		Female	Male
16	11		10	7

MM: progeny of the minus-selected parents of the second generation ($n=25$) (originating from 2 bucks and 6 does).

PP: progeny of the plus-selected parents of the second generation ($n=57$) (originating from 2 bucks and 8 does).

All of the experimental animals originated from does between the 2nd and 5th parities and litters which were equalized to 7–9 kits.

2.2. Housing and feeding

Third generation kits ($n=82$) were weaned at 5 week of age. After weaning they were housed in fattening cages (400 mm × 400 mm × 350 mm, 2 rabbits/cage). Temperature was 15–16 °C and the lighting period was 16 h/day. Until 8 week of age rabbits consumed commercial diets (10.3 MJ of DE/kg, 14.5% CP, 17.5% crude fiber, medication), then a non-medicated diet (10.6 MJ of DE/kg, 16.0% CP, 16.0% crude fiber, no medication) was offered *ad libitum*. Both diets were provided by Purina, Kaposvár, Hungary.

2.3. Data collection

Each week from 5 to 10 weeks, rabbits were weighed individually and the mean daily feed intake per cage was measured. ADG per animal and feed conversion ratio (FCR) per cage were calculated. Mortality was recorded daily. At 10 week of age, 24 rabbits were randomly selected from each of the two groups and were taken for CT examination. Three rabbits were fixed into a plastic constraint simultaneously without anesthesia (Romvári et al., 1996). Evaluation of the VTM was as described above.

2.4. Slaughter and dissection

After CT examination the rabbits ($n=48$) were slaughtered and dissected according to the recommendations of World Rabbit Science Association (Blasco and Ouhayoun, 1996). Rabbits were weighed before slaughter then were bled after electric stunning. Warm carcasses were weighed (with head, heart, lungs, liver, kidneys, periscapular and perirenal fat) then placed in a chilled room at 4 °C for 24 h. The chilled carcasses were weighed again, then the heart, lungs, liver, kidneys, periscapular and perirenal fat were removed and weighed. The head was