THESES OF DOCTORAL (Ph.D.) DISSERTATION

UNIVERSITY OF KAPOSVÁR
FACULTY OF ANIMAL SCIENCE
Department of Pig and Small Animal Production

Head of the Doctoral School:
Dr. PÉTER HORN
Member of the Hungarian Academy of Sciences

Supervisor:
Dr. ZSOLT SZENDRŐ
Doctor of the Hungarian Academy of Sciences

EXAMINATION ON CARCASS TRAITS AND MEAT QUALITY OF RABBIT

Written by:
SZILVIA METZGER

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1. ANTECEDENTS OF THE RESEARCH, OBJECTIVES

In rabbit meat export the dissected and processed products have more and more importance. To meet all demands, the higher dressing out percentage, higher proportion of the main carcass parts as well as meat quality parameters (due to the longer storage time, processing and consumer's demands) have more importance.

The only criterion of the rabbit purchase is that they reach the 2.5 kg body weight. Thus, the main aim of the producers is that rabbit reach this weight as soon as possible. This is why the main viewpoint of the selection is the higher body weight gain, however, the carcass traits of rabbits slaughtered in younger ages are not meet the modern requirements absolutely. Beside the selection for body weight gain, Pannon White rabbits are also selected for carcass traits by computerised tomography (CT) (SZENDRŐ *et al.*, 2004). It is very important to know whether carcass traits of CT selected Pannon White rabbits differ from that of other breeds and hybrids and if so, then to what extent. Besides, nowadays the expectations of customers have altered considerably. More and more consumer needs meat which comes from animals housed under more natural-like circumstances. According to our knowledge the separated effect of energy intake on the carcass traits and meat quality of rabbits has not been studied yet. Recently an investigation of divergent selection was carried out by TOBEC-method for the body fat content of rabbits, as reported by LÉVAI and MILISITS (2002). These two populations, differing in body fat content, could be suitable to study the combined effect of genotype and energy intake.

In the dissertation the effects of some basic factors (inter-breed, selection, housing, nutrition) on carcass traits and meat quality was examined. The aims of the experiments were:

- Examing the common and separated effects of age and body weight on carcass traits and chemical composition of meat of Pannon White rabbits.
- Comparing the progenies of a hybrid terminal male line selected for body weight gain (Hyplus) and Pannon White males selected for body weight gain and carcass traits (by CT) in order to learn more about the effect of selection for different traits.
- Comparing the influence of the wire net cage housing with rearing rabbits in pen (in large group on deep litter) on carcass traits and meat quality.
- Examining the effect of energy intake on carcass traits and meat quality of rabbits selected divergently for body fat content.

2. MATERIAL AND METHODS

2.1. Animals, housing

Experiments were mostly carried out at the rabbit farm of the University of Kaposvár on Pannon white growing rabbits. Animals were weaned at 35 days of age. After weaning, they were housed in fattening cages made of wire mesh until slaughtering (2–3 rabbits per cage). The rabbit house had 15–16 °C temperature in winter and 22-25 °C in summer, a 16L:8D (light:dark) lighting cycle and overpressure ventilation. The rabbits were usually fed a commercial diet (energy: 10.6 DE MJ/kg, crude protein: 16%, ether extract: 3.0%, crude fibre: 16.0%) *ad libitum*. Drinking water was available *ad libitum* from nipple drinkers.

2.2. Slaughtering and dissection procedure and meat quality evaluation

At the end of the experiments rabbits were slaughtered and dissected according to the method of BLASCO and OUHAYOUN (1996). Meat samples of *m. Longissimus dorsi* (MLD) and hindleg meat (HL) were collected from for meat quality analysis. Ultimate pH, colour and chemical composition were determined.

2.3. Statistics

Data were evaluated by analysis of variance and of covariance using the SPSS 10.0 programme package (SPSS FOR WINDOWS, 1999). Groups were compared by Tukey's test or LSD test (in case of analysis of covariance). Effect of gender was not taken into consideration, since according to the literature it has no effect on carcass traits and meat quality.

2.4. Effect of age and body weight

Three randomly selected groups of does were mated with an interval of 10 days, thus the young rabbits were born at different times. Rabbits – independently of their gender – belonging to the three age groups (n=238) were slaughtered on the same day, and thus the animals were 10.5, 12 and 13.5 weeks old, respectively, with the average body weight of 2.53, 2.84 and 3.15 kg, respectively. Thus 0.3 kg difference was found between two neighbouring age categories. This is why the rabbits were slaughtered at a body weight 0.3 and 0.6 kg higher and lower than the average weight within each age group. In this way the weight difference between two neighbouring weight and age groups was equally 0.3 kg.

Data were evaluated by SAS (SAS INSTITUDE, 2001) due to the unbalanced rabbit number per group. Since we had 5 body weight categories within age groups, we could analyse the effect of body weight within each age group separately. The separated effect of age was also examined in body weight categories (between 2.49-2.63 and 3.09-3.25 kg) which had rabbits from each age group. Each body weight category was evaluated separately. Thus, we had the possibility to study the effect of age in rabbits of same body weight but different age and *vica versa* to study the effect of body weight in rabbits of same age but different body weight. In these evaluations one-way analysis was used.

2.5. Comparison of different genotypes

Purebred Pannon White (PP, n=84) and Hyplus hybrid terminal cross (HH, n=77), as well as crossbred growing rabbits (Hyplus PS59 bucks × Pannon White does: HP, n=79; and Pannon White bucks × Hyplus PS19 does: PH, n=97) were included into the experiment. The PS19 females are characterised by high prolificacy and early maturity, while the PS59 males by high body weight gain but late maturity. Pannon white rabbits are selected for body weight gain and for carcass traits by CT as well (SZENDRŐ *et al.*, 2004) The average mature body weight of the genotypes was different (P♂: 4.8 kg; P♀: 4.4 kg; H♂ (PS59): 5.6 kg; H♀(PS19): 4.1 kg).

Half of the Pannon White does were inseminated with semen of Pannon White (P) bucks, while the other half with semen collected from the Hyplus PS59 (H) terminal bucks and *vica versa*, half of the Hyplus PS19 (H) parent does were inseminated with semen of H bucks, while the other half with semen of P bucks. PP and HP rabbits were born at the University of Kaposvár while HH and PH genotypes were born at the rabbit farm of Olivia Ltd., at the same time. After weaning at 5 weeks of age, the rabbits born in Kaposvár were transported to the farm of Olivia Ltd.; thus, all the genotypes examined were housed in the same building and fed the same diet up to 12 weeks of age. Rabbits were slaughter without fasting at 12 weeks of age.

2.6. Influence of housing rabbits in cages or in pens on deep litter

The experiment was carried out at the rabbit farm of Lab-Nyúl Ltd. in Gödöllő. At 5 weeks of age, 161 Pannon White rabbits were randomly divided into two groups. Half of the rabbits were housed in cages (0.40 × 0.40 m, 0.35 m high, 3 rabbits/cage, 18.7 rabbits/m^2, n=81) while other half in pen on deep litter (3 x 3.3 m, 80 rabbits/pen, 8.1 rabbits/m^2 n=80). The

0.2 m thick wheat straw litter was placed onto the concrete floor and it was refreshed every second week. At the end of the trial (at 13 weeks of age) all the surviving rabbits (cage: n=68, pen: n=52) were slaughtered after 24-hour fasting.

2.7. Effect of genotype (selection for body fat content) and energy intake

Pannon White rabbits applied in the experiment were selected by TOBEC-method according to the estimated body fat content (LÉVAI and MILISITS, 2002). In this study rabbits weaned at 28 days of age selected for high (HFAT, n=78) or low body fat content (LFAT, n=48) were used. Both genotypes were randomly divided into three dietary groups.

The digestible energy content (DE) of each diet was similar (treatment H, M and L: 11.72, 11.60 and 11.66 MJ/kg, respectively), while the crude protein, crude fibre, mineral and vitamin contents were about 10 and 20% higher in the M and L diets, resp., than in the H group. The H diet was fed *ad libitum*, thus the energy intake of this group was the highest (H, n=44). According to the daily feed intake of group H the other two groups were fed restricted to about 90 (M, n=40) or 80% (L, n=42) of the *ad libitum*, thus, the energy intake was reduced by 10 (M) or 20% (L). Since proportionally to the reduction of feed intake the nutrient density of diets was increased, the intake of other nutrients remained similar in the experimental groups. Rabbits were slaughtered at 12 weeks of age. Meat samples were transported to the University of Bologna where the meat quality analyses were done.

3. RESULTS

3.1. Effect of age and body weight

Dressing out percentage increased with the increase of age in all body weight categories, however, the differences were significant only comparing the 10.5 weeks rabbits with other age group (between 10.5 and 12 weeks of age in the body weight categories of 2.49-2.63; 2.78-2.92 and 3.09-3.25kg the increase was 2.9; 1.2 and 2.2%; resp.; $P<0.05$). With the increase of body weight (within a given age category) the dressing out percentage improved, although the difference was significant only at 10.5 weeks of age (between 1.86-2.05 and 2.78-2.92kg it was 3.3%; $P<0.05$). The effect of age on the ratio of the fore part of the carcass depended on the body weight: between 10.5 and 13.5 weeks of age in the body weight categories of 2.49-

2.63 and 2.78-2.92kg the decrease was 2.5 (P<0.05) and 1.5% (P<0.05) resp., , while in 3.09-3.25kg no difference was found. The ratio of the fore part increased in heavier rabbits at 13.5 weeks of age (between 2.49-2.63 and 3.65-3.84kg it was 2%; P<0.05), however, at 12 weeks of age significant difference was found in only one case, while at 10.5 weeks of age no any change was found. The ratio of the intermediate part of the carcass was not affected by age but it increased in rabbits of higher body weight, however, significant (P<0.05) difference was found only between 10.5 and 13.5 weeks of age. The ratio of the hind part of the carcass increased in older animals (between 10.5 and 13.5 weeks of age in the body weight categories of 2.49-2.63, 2.78-2.92 and 3.09-3.25kg the increase was 1.8% /P<0.05/, 2.4% /P<0.05/ and 0.6% /NS/, resp.). While it decreased in rabbits of higher body weight, and this decrease was higher in older rabbits (between the lightest and the heaviest group at 10.5, 12 and 13.5 weeks of age it was 2.3, 3.0 and 4.7%, resp.). The ratio of the perirenal fat to reference carcass significantly decreased with age in all body weight categories (between 10.5 and 13.5 weeks of age in the body weight categories of 2.49-2.63, 2.78-2.92 and 3,09-3,25kg it was 0.52, 0.74, and 0.46%, resp., P<0.05), but it significantly increased in rabbits of higher body weight (between the lightest and the heaviest rabbits at 10.5, 12 and 13.5 weeks of age the increase was 1.26, 1.23 and 1.37%, resp.).

Meat samples of the hind leg meat (HL) and that of *m. Longissimus dorsi* (MLD) were subjected to chemical analysis from each group. With the advancement of age the moisture content of the HL increased (between 10.5 and 13.5 weeks of age in the body weight categories of 2.49-2.63, 2.78-2.92 and 3.09-3.25kg it was 0.4 /NS/, 0.9 /P<0.05/ and 1.5% /P<0.05/, resp.), while that of the MLD did not change. With the increase of body weight, moisture content decreased in both the HL and in the MLD (between the lightest and the heaviest rabbits at 10.5, 12 and 13.5 weeks of age in the HL the decrease was: 3.6, 1.8 and 1.6%, P<0.05, resp.; in the MLD it was 0.5, 0.5 and 0.8%, P<0.05, resp.). The fat content of both HL and MLD decreased in older animals (between 10.5 and 13.5 weeks of age in the body weight categories of 2.49-2.63, 2.78-2.92 and 3.09-3.25 kg in the HL the decrease was 1.03 /NS/, 1.48 /P<0.05/ and 2.25% /P<0.05/, resp.; in the MLD it was 0.03 /NS/, 0.28 /P<0.05/ and 0.31% /P<0.05/, resp.). While it increased in rabbits of higher body weight (between the lightest and the heaviest rabbits at 10.5, 12 and 13.5 weeks of age in the HL the increase was 4.07, 2.2 and 1.91%, resp., P<0.05; in the MLD it was 0.28, 0.62 and 0.51%, resp., P<0.05).

3.2. Comparison of different genotypes

Pannon White breed had an advantageous influence on dressing out percentage (PP: 58.0%; PH: 58.7%; HP: 57.7%; HH: 57.6%; P<0.001) and on the weight of the *m. Longissimus dorsi* (PP: 152 g; PH: 143 g; HP: 137 g; HH: 136 g; P<0.001). Thus, from the viewpoint of dressing out percentage and the volume of the *m. Longissimus dorsi* the usage of Pannon White genotype is advantageous. The fat content of the carcass was lower in the progeny of the Hyplus PS59 bucks (1.15, 1.16, 0.89 and 0.85% for PP, PH, HP and HH rabbits, respectively; P<0.001).

Significant differences were found in the moisture and fat content of hindleg meat between the progenies of purebred Pannon White and hybrid terminal cross rabbits (moisture content: PP: 75.5%, HH: 76.1%, P<0.05; fat: PP: 2.38%, HH: 1.46%; P<0.001), while the two crossed genotypes did not differ from PP and HH groups (moisture content: HP and PH: 76.0%; fat: HP: 1.96%, PH: 1.56%). The pH and colour were similar in all genotypes.

3.3. Influence of housing rabbits in cages or in pens on deep litter

At 13 weeks of age the cage-housed rabbits had higher body weight (2437 vs. 2318 g; P=0,01) and dressing out percentage (61.0 vs. 59.8%; P=0,01), lower proportion of fore- (30.9 vs. 32.0%; P<0,001) and hind part of the carcass (37.3 vs. 40.0%; P<0.001), and higher proportion of intermediate part (30.2 vs. 27.2%; P<0,001) than the pen-housed animals. The weight and the ratio of the perirenal fat was higher in the cage-housed rabbits (20.7 vs. 10.5 g; P<0.001 and 0.83 vs. 0.45%; P<0.001, resp.) compared to pen-housed group.

The meat on the hind legs (HL) and the *m. Longissimus dorsi* (MLD) of cage-housed rabbits contained less water (HL: 73.9 vs. 75.0%, P=0.02; MLD: 74.0 vs. 74.6%, P=0.01) but more fat (HL: 3.36 vs.2.48%, P=0.05; MLD: 0.90 vs.0.65%; P=0.05) than those of kept in pen. The protein content differed significantly only in the MLD, it was higher in cage-housed rabbits (23.9 vs.23.6%; P=0.03). Housing system had no effect on ash content and pH of the meat samples.

3.4. Effect of genotype (selection for body fat content) and energy intake

Effect of genotype on carcass traits was less marked than that of energy intake. Selection for high body fat content significantly improved the dressing out percentage (58.2 and 57.3% in HFAT and LFAT respectively;

P<0.01), and reduced the ratio of the full gastrointestinal tract related to liveweight (13.9 and 14.4%, respectively; P<0.05). Reduction of energy intake decreased the body weight and the weight of the body parts significantly (P<0.001), while it had no effect on dressing out percentage (H, M, L: 57.8, 58.0 and 57.4, resp., NS). In group H the proportion of fore part to carcass was significantly higher (H: 29.9, L: 28.9%; P=0.01) while that of the hind part was lower than in group L (H: 37.1, L: 38.0%; NS).
Genotype influenced the overall meat quality traits to a lower extent than energy intake. The *L. lumborum* muscles of HFAT rabbits exhibited a lower (P<0.01) moisture content (HFAT: 76.09, LFAT: 76.52%, P<0.01) and darker (L*: HFAT: 53.45 LFAT: 54.41; P<0.05) and less yellow (b*: HFAT: 0.42 LFAT: 0.81; P<0.05) colour. Restricted rabbits (L) exhibited higher values of pH (H: 5.73, L: 5.87; P<0.01) associated with lower values of cooking loss (H: 19.06, L:17.82%; P<0.01) and a higher moisture content (H: 75.68, L:76.86%; P<0.01). Moreover, L rabbits also produced lower values of redness (a*: H: 3.35, L: 2.21; P<0.01) and yellowness (b*: H: 0.91, L: 0.23; P<0.01). Neither the genotype nor the energy intake affected significantly the lipid content of the hindleg meat. Energy intake restriction resulted in a lower amount of total SFA (H: 35.75, L: 32.13%; P<0.01) and total MUFA (H: 28.64, L: 20.98%; P<0.01) as well as higher content of PUFA (H: 34.85, L: 45.48%; P<0.01) in the hindleg meat. These results were related to the higher inclusion rate of sunflower oil in the feed L (4.2%) in respect with feed H (2.5%).

4. CONCLUSIONS AND RECOMMENDATIONS

In the majority of previous studies the effect of age could not be separated from that of the body weight and *vica versa*. Studies of the separated effects of the two factors often throw a new light upon changes of the carcass traits. Determination of the ideal slaughter age or body weight is complex, since it could depend on products. According to our results dressing out percentage is improved by both the advancement of age and the increase of body weight. In the viewpoint of the intermediate part rabbits of higher body weight, while in case of the hind part older rabbits are the advantageous. Faster growth (higher body weight at a given age or given body weight at a younger age) results higher intramuscular fat content. The increase in the fat content of meat is not in contradiction with the consumer's demand on rabbit meat of low fat content. The fat content of the MLD scarcely differs from the 1%, while that of the HL mostly varies between 2 and 5%, which indicates that meat of older or heavier rabbits have excellent dietetic value.

The efficacy of the selection of Pannon White rabbits based on CT was established since the weight and the ratio of *m. Longissimus dorsi* were higher in the progenies of Pannon White genotype. Consequently, both the weight and the ratio of the intermediate part increased resulting higher dressing out percentage. Although the correlation between body weight gain and carcass traits is negative, it is possible to select for both traits simultaneously. Thus, the muscle development at younger age could be increased in breeds of larger adult body weight and late maturity. In this way it is possible to select a terminal sire line which has high body weight gain and good carcass traits at 2.5 kg as well.

Housing rabbits under natural-like circumstances (in larger group, in pen on deep litter) their body weight gain decrease, thus they reach the slaughter weight later. Dressing out percentage of these rabbits is poorer, while the ratio of the hind part to carcass increases due to the increased locomotor activity. Decrease in fat depots and muscle fat content is advantageous. However, due to the longer fattening period the rearing costs could be increased, which could be compensated partly or totally by higher price and lower investment costs. Rearing rabbits on deep litter in larger group, the risk of injuries on account of aggression and that of digestive diseases (coccidiosis) could be higher.

Since the dressing out percentage of rabbits selected for high body fat content was higher than that of rabbits selected for low body fat content, thus, the HFAT rabbits could be favourable for the slaughterhouses. It would be interesting to prove with more data that rabbits selected for high body fat content are really matured earlier, thus, the intensive growth of their musculature starts earlier and consequently their dressing out percentage and meat production are better. This could have a great practical benefit. The energy intake had no effect on dressing out percentage. However, the restriction of energy intake was disadvantageous – even if the intake of digestible nutrients was similar – since the weight gain decreased, thus, rabbits reached the same body weight later. The selection for body fat content had lower influence on the overall meat quality traits than the energy intake. The higher PUFA/SFA ratio in rabbits feed a diet of lower energy (restricted) could be advantageous for human consumption. These results were caused by the differences in diet composition and not by the energy restriction. Thus, the advantageous fatty acid composition of meat could be reached with a well-formed diet fed *ad libitum*.

5. NEW SCIENTIFIC RESULTS

According to our results the fat content of meat decreases in older animals within a given body weight, while it increases in rabbits of higher body weight within a given age.

Comparing with other genotypes, the selection of Pannon White rabbits based on CT was found to be effective, resulting higher weight and ratio of the intermediate part and dressing out percentage.

Reducing the energy intake – even if the intake of digestible nutrients is similar – does not affect the dressing out percentage of rabbits, although their body weight gain decreases; thus it makes the fattening time longer.

6. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

6.1. Scientific papers

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