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Response of fattening rabbits reared under different housing conditions. 2. Carcass and meat quality

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ABSTRACT

This 2×2×2 factorial experiment was conducted to study the effects of housing system (pair caged – cage – : 2 rabbits/0.122 m^2 vs open top pen housed – pen – : 13 rabbits/0.86 m^2; same stocking density), floor type (wire mesh vs plastic net), and environmental enrichment (with vs without gnawing stick) on the meat quality of Pannon White growing rabbits ($n=64$). The housing system significantly influenced slaughter weight (2590 vs 2531 g in cage or pen, respectively; $P<0.01$), reference carcass (RC) weight (1266 vs 1234 g; in cage or pen, respectively; $P<0.05$), and the hind leg meat to bone ratio (6.11 vs 5.62 in cage or pen, respectively, $P<0.001$). The animals reared in pens showed paler meat with lower pH_u than that of those reared paired in cages. Hind leg meat dry matter and protein content were also influenced by the housing system (26.3 vs 25.9%, 21.9 vs 21.6%; in cage or pen, respectively; $P<0.05$). Pen housed rabbits had significantly heavier femur and tibia bone weight and higher fracture toughness than pair caged rabbits. Floor type affected the fore part/RC weight ratio (29.2 vs 29.6% of the RC on plastic net or wire mesh, respectively). Gnawing stick presence increased slaughter yield (59.0 vs 58.3%; $P<0.05$), RC weight (1266 vs 1236 g; $P<0.05$) and the forepart/RC ratio (29.6 vs 29.2% RC; $P<0.05$) while significantly reducing the meat colour b^* value and increasing m. Longissimus dorsi shear force (0.60 vs 0.50 kg/cm^2; $P<0.01$). The hind leg meat fatty acid profile was only slightly influenced by experimental factors. Although this study showed pair caged rabbits to have increased carcass weight with better meatiness and other meat quality traits, hind leg bone strength was shown to be higher in pen housed rabbits.

1. Introduction

Fattening rabbits are conventionally caged by pair (Italy and Hungary) or in small groups of 6 to 10 rabbits (France, Spain, Portugal, USA). Pair caging may negatively affect animal welfare however (Dal Bosco et al., 2002), and the ethical quality of our meat is coming to assume greater and greater importance (Dal Bosco et al., 2002; Bessei et al., 2006). Although numerous studies have been conducted on the effects of housing system, floor type, and the use of environmental enrichments, these factors have often been approached separately and few authors have considered the effects on meat quality (Jordan et al., 2004; Kermauner et al., 2004). This study dealt with the combined effect of housing system (cage vs pen), floor type (wire mesh vs plastic net) and environmental enrichment (with vs without gnawing stick) on the carcass traits and meat quality of growing rabbits. The effects on live performance, health status, and welfare are reported in Princz et al. (2009-this issue).

2. Material and methods

2.1. Animals, housing, and diets

A detailed description of the experimental site, feeding, animals, and their management is provided by Princz et al. (2009-this issue). The experimental design is shown in Fig. 1.

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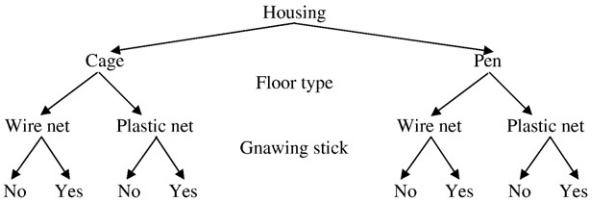

Fig. 1. Experimental design.

In a 2×2×2 factorial study, 176 Pannon White rabbits of both sexes were randomly pair caged (cage) ($n=72$; 2 rabbits/0.122 m^2; 0.33 m×0.37 m) or pen housed in open top small pens (pen) ($n=104$; 13 rabbits/0.86 m^2; 0.50 m×1.72 m) with the same stocking density of 16 rabbits/m^2 after taking the space occupied by the feeders in the pens into account. One half of the cages and pens was floored in wire mesh (with 10×50 mm holes and 2 mm wire diameter), whereas the other half was floored in plastic net (4 mm width, the diagonals of the parallelogram forming 15 and 25 mm holes).

In every second cage and pen, peeled wooden gnawing sticks (made of *Robinia pseudoacacia*) were attached horizontally to the wall 20 cm above floor level. In cages, the gnawing stick was 10 cm long with a 3 cm diameter; in pens, there were two gnawing sticks, each 33 cm long with 3 cm diameter). A metal plate inserted between the gnawing stick and the wire mesh wall to prevent gnawing by neighboring rabbits. No gnawing sticks were provided in the other half of the cages and pens.

2.2. Slaughter traits and muscle sampling

The 176 rabbits were weighed in the experimental building the late afternoon; 64 rabbits (8 per treatment) within the range of the initial group's average weight ± 2 SD were randomly selected for carcass and meat quality analysis. Selected animals were numbered for slaughter order at random and not subjected to fasting.

The next morning (5.00 am), the selected rabbits were transferred in small groups to the slaughter facility near the experimental building in the slaughter order above, in this way minimizing stressful conditions. The rabbits were then weighed (SW), electrically stunned, and slaughtered within 3 h. At slaughter, the rabbits were 11 weeks old. The slaughtering and carcass dissection procedures followed the World Rabbit Science Association (WRSA) recommendations described by Blasco and Ouhayoun (1996). The slaughtered rabbits were bled, and then the skin, genitals, urinary bladder, gastrointestinal tract and the distal part of legs were removed. Carcasses (with head, thoracic cage organs, liver, kidneys, perirenal and scapular fat) were weighed (hot carcass; HC), then chilled at +4 °C for 24 h in a ventilated room.

After 24 h chilling, the chilled carcasses (CC) were weighed.

The head, thymus, trachea, oesophagus, heart, lungs, liver and kidneys were removed from each carcass to obtain the reference carcass (RC), which includes the meat, bones and fat depots. The carcasses were then cut between the 7th and 8th thoracic vertebra and between the 6th and 7th lumbar vertebra to obtain the fore, intermediate, and hind parts, which were weighed separately. The slaughter yield (CC weight as % of SW) and the ratio of the organs and carcass parts to either the CC or to the RC weight were calculated as required.

Immediately after weighing, the intermediate (loin joint) and hind (hind leg — HL) parts were individually packed in polyethylene bags, sealed, ice-cooled in portable refrigerators and transported to the Department of Animal Science of the University of Padova (Italy) for meat quality analysis. During transportation, the temperature of the samples was maintained at +4 °C. The samples arrived at the Padova Department laboratory at 6.00 pm (36 h *post mortem*) and were stored in a ventilated refrigerator at +4 °C.

2.3. Rheological and analytical measurements

Rheological and analytical measurements were performed on the left HL meat (Warner–Bratzler Shear Force —WBSF; pH_u and $L^*a^*b^*$ colour on Biceps femoris muscle — BF), on the right HL (bone characteristics, muscle to bone ratio, chemical composition, cholesterol content, and Fatty Acids — FA profile), and on the loin joints (Water Holding Capacity — WHC; pH_u and $L^*a^*b^*$ colour of *Longissimus dorsi* — LD muscle).

At 36 h *post mortem*, meat colour was assessed on the surface overlying raw LD ($n=64$) and BF ($n=64$) muscles. A Minolta CR100 chromameter (Minolta, Osaka, Japan) was set to the L^* (lightness), a^* (redness), b^* (yellowness) scale (CIE, 1976). Values corresponded to the average of two measurements at each sample.

Given that pH can be considered as having reached its ultimate value (pH_u) after 24 h of chilling (Hulot and Ouhayoun, 1999), we measured pH_u *in situ* on both LD and BF 36 h *post mortem* using a combined Ingold electrode (406 M3).

After recording colour and pH_u, all the samples were stored at +4 °C until the next measurements 48 h *post mortem* when the left HL and loin joints were weighed and frozen (−20 °C) until cooking loss (loin joint) and WBSF (LD and HL) were determined. The right HL was deboned, and the meat/bone ratio was calculated (Blasco and Ouhayoun, 1996), and then the raw meat was ground, freeze-dried, and analysed for moisture, fat, ash, energy (A.O.A.C., 1984) and cholesterol (Casiraghi et al., 1994). Protein content – including glucidic molecules and their catabolites (0.25%) (Ouhayoun et al., 1990) – was calculated by difference.

The raw femur and tibia bones were measured for weight, length (femur bone), diameter, and fracture toughness (WBFT). Bone diameter was measured using a dial caliper (±0.02 mm) at the level of major thickness at the mid-diaphysis corresponding to the breaking point. The bones were submitted to a three-point flexure test conducted with a universal testing machine (Instron 1000). The distance between the two fulcra points supporting the bones was 45 and 38 mm, for the femur and tibia bones, respectively; the load rate was 5 mm/min. The bones were constantly oriented for testing with their natural convex shape downwards. The flexure fixture used was specific for testing bone fracture toughness (provided by Instron).

Each loin joint was weighed again either after thawing (for 24 h at +4 °C) or after cooking to determine the drip loss (calculated as the 48/24 h *post mortem* weight ratio), the thawing loss (as the ratio of thawed weight/48 h *post mortem* weight), and the cooking loss (the cooked/thawed weight ratio), respectively.