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Effect of housing conditions on production, carcass and meat quality traits of growing rabbits

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ABSTRACT

Production, carcass traits and meat quality of rabbits housed in cages or in different pens were compared. Rabbits (n = 579) were sorted into 5 groups: C = cage (2 rabbits/cage); pen without platform: P11 = 9 rabbits/pen; P16 = 14 rabbits/pen; pen with platform: PW = wire net platform, 14 rabbits/pen; PD = platform with straw-litter, 14 rabbits/pen. Feed intake and average daily gain between 5 and 11 weeks, and body weight at 11 weeks were significantly higher in C rabbits than that of the mean of pen-housed groups, while the PD group had the lowest growth performance. C rabbits had the smallest hind part to reference carcass ($P < 0.001$) and the largest percentage of perirenal and scapular fat ($P < 0.001$). The meat/bone ratio was the largest in group C ($P < 0.05$). Differences were recorded in a* value and lipid content of m. *Longissimus dorsi*. Rabbits housed in cages generally had the best performance whereas those housed in pens with platform exhibited the worst.

1. Introduction

An increasing proportion of consumers recognize animal welfare aspects of livestock production and prefer to buy meat of animals kept in an environment with adequate housing. However, the human idea of the optimal housing conditions of a certain species may not coincide with the real needs for that species. Thus animal behavior and animal welfare are research areas with several unanswered questions. According to the survey of EFSA (European Food Safety Authority (EFSA), 2005) and also more recent studies (Szendrő & Luzi, 2006) there are several experiments that need to be conducted in rabbit production before specific directives can be given.

In small cages, rabbits have limited space for moving (Szendrő & Dalle Zotte, 2011), however, numerous experiments conducted with growing rabbits have shown that higher group size results in higher stress, lower feed intake and weight gain, decreased slaughter performance, increased infection and mortality, and higher occurrence of lesions on the body due to aggression (Szendrő & Dalle Zotte, 2011). In the larger groups the dressing out percentage was poorer, the ratio of fore part to reference carcass decreased, while the hind part increased, fat deposits and meat/bone ratio also decreased (Combes, Postollec, Canquil, & Gidenne, 2010; Dal Bosco, Castellini, & Mugnai, 2002; Dalle Zotte, Princz, Metzger, et al., 2009; Szendrő et al., 2009). Because of the higher frequency of aggressiveness, living under stressful conditions resulted in lower pH_u and lighter colored meat. Not only fat deposition but the fat content of the meat decreased, while water content increased (Combes et al., 2010; Dal Bosco et al., 2002; Szendrő, Princz, et al., 2009). At the same time, the PUFA, n-6, n-3 and n-6/n-3 ratio increased with stressful housing conditions (Dal Bosco et al., 2002; Dalle Zotte, Princz, Metzger, et al., 2009). However, as reported by Dalle Zotte, Princz, Matics, et al. (2009) rabbits require social interactions. In this experiment cage-rearing with different types of pens is compared.

The most critical element of rabbit housing is the floor type because the animals have direct and continuous contact with the floor (resting, locomotory behavior). In large scale rabbit breeding, keeping the animals on a wire mesh floor became widespread 40–50 years ago. This method avoids the animals contact with their feces thus hinders coccidia infection. There is a general belief that deep litter is an optimal floor type for rabbits; however, rabbits can consume the spoiled litter material (Dal Bosco et al., 2002; Jekkel & Milisits, 2009; Lambertini, Vignola, & Zagnini, 2001) which increases the risk of digestive diseases (primarily coccidiosis) and mortality (Dal Bosco et al., 2002). Because of litter consumption (containing low levels of nutrients) the rabbits consume less pellets and show decreased weight gain, body weight, dressing out percentage, meat/bone ratio and amount of fat deposits (Dal Bosco et al., 2002; Lambertini et al., 2001; Metzger et al., 2003; Trocino, Xiccato, Majolini, & Fragkiadakis, 2008). If provided with a free choice of location, above 15–16 °C the rabbits generally show a preference for wire mesh floors as opposed to deep litter (Morisse, Boilletot, & Martrenchar, 1999; Orova, Szendrő, Matics, Radnai, & Biró-Németh,

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2004) because digestive heat dissipation is easier on that surface (Bessei, Tinz, & Reiter, 2001).

Thus there is a great difference between consumer expectations and the demands of real animal welfare with regard to optimal floor type for rabbits. A compromise could be achieved through the use of cages provided with both wire mesh and deep litter floors, but the negative aspects of litter consumption were still the same as described for deep litter floor (Jekkel, Milisits, & Bíróné Németh, 2008; Morisse et al., 1999). Keeping the rabbits after weaning on wire net floors, and placing the deep litter into the pens only during the final period of growth (Jekkel et al., 2008; Kustos, Tóbiás, Kovács, Eiben, & Szendrő, 2003; Princz, Nagy, Radnai, Gerencsér, & Szendrő, 2008) seem to be a better solution. In this experiment a new combination of wire net and deep litter floor is tested, a wire-mesh pen with an elevated platform with deep litter on it.

In order to answer the questions raised and surrounding this issue an experiment was conducted to compare production, slaughter and meat quality traits of growing rabbits housed in cages or in different types of pens (with or without an elevated platform; wire-net or deep-litter platform). The main questions were: What are the differences between the cage and pen housing, between pen housing with or without platform and among the five different housing systems?

2. Materials and methods

2.1. Animals, feeds, experimental design and management

The experiment was conducted in three replications at the rabbit farm of the Kaposvár University using Pannon White growing rabbits (n = 579). The rabbits (weaned at the age of 5 weeks) received a commercial diet (5–9 weeks of age: 10.3 MJ DE/kg, 14.5% crude protein, 17.5% crude fiber, medicated with 1 ppm Clinacox (diclazuril), 500 ppm OTC, 50 ppm Tiamulin; at 9–11 weeks of age: 10.6 MJ DE/kg, 16% crude protein, 16% crude fiber). A continuous 16L:8D lighting schedule was applied, and the temperature ranged between 15 and 19 °C.

At weaning, individually marked rabbits with ear tattoos were randomly assigned to the following 5 groups:

Group C (control group): conventional cage (0.12 m^2), wire net floor (60 cages of 2 rabbits/cage, 16.6 rabbits/m^2; n = 120).

Other rabbits were housed in pens (having a basic area of 0.86 m^2), the floor type was wire net, the feeder was placed at the end of the pen while the two nipple drinkers were located at the opposite ends of the pen. The distance between the feeder and drinkers was 1.8 m.

Pens without elevated platform:

Group P11: 9 pens of 9 rabbits/pen, 10.5 rabbits/m^2 (n = 81);
Group P16: 9 pens of 14 rabbits/pen, 16.3 rabbits/m^2 (n = 126).

(The stocking density was 16.3 rabbits/m^2 in the pens with platforms when the platform was not considered in the basic area of the pen. Taking into account the platform the stocking density was 10.9 rabbits/m^2.)

Pens with elevated platform: The elevated platforms, with an area of 0.43 m^2, were placed at a height of 0.4 m from the pen floor, in the middle area of the pen. To facilitate access to the platform, a 0.20 × 0.25 m sized box (with a height of 0.2 m) was placed in each pen.

Based on the platform types, two additional treatments were applied:

Group PW: the elevated platform was made of wire mesh. Fourteen rabbits were placed in each of 9 pens. Stocking density was 16.3 (related to the floor surface), or 10.9 rabbits (including the platform surface) per m^2 (n = 126).
Group PD: the elevated platform was covered with a 5 cm layer of wheat straw. The straw was replaced weekly and when it was necessary dry straw was added. Fourteen rabbits were housed in each of 9 pens, which is equivalent to a stocking density of 16.3 (floor surface), and 10.9 (including the platform surface) rabbit/m^2, respectively (n = 126).

Individual body weight (BW) and feed intake (FI) per cage or pen were measured at 5, 7, 9 and 11 weeks. Mortality was recorded daily. Average daily gain (ADG), FI, feed conversion ratio (FCR) and mortality were calculated for every 2-week period and also for the total period between the ages of 5 and 11 weeks. Production traits were examined in all replications, but only the rabbits of the first replication were slaughtered.

2.2. Slaughter traits and muscle sampling

At 11 weeks of age all rabbits were weighed at the experimental farm. One hundred and fifty five rabbits of the first replication (32, 18, 33, 36 and 36 rabbits for C, P11, P16, PW and PD groups, respectively) were randomly selected for carcass and meat quality analysis representing the average weight and variability of each group. Selected animals were transported to a slaughterhouse located 200 km from the rabbit farm. After removing the rabbits from the cages and pens they were slaughtered within 6 h.

The slaughtering and carcass dissection procedures followed the recommendations of the World Rabbit Science Association (WRSA), described by Blasco and Ouhayoun (1996). At the slaughterhouse, rabbits were weighed (SW), electrically stunned and bled. Then, the skin, genitals, urinary bladder, gastrointestinal tract and the distal parts of the 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 hour chilling, the chilled carcasses (CCs) were weighed. The head, thoracic cage organs (thymus, trachea, esophagus, heart, lungs — LHW), 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, mid, and hind parts, which were weighed separately. Also scapular and perirenal fat was dissected and weighed. The dressing out percentages (HC, CC and RC 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.

The *Longissimus dorsi* (LD) muscle of both sides and muscles of the hind leg (HL) of a randomly selected 15 rabbits per experimental group were separated and individually packed in polyethylene bags, sealed, ice-cooled in portable refrigerators and transported to the Department of Animal Medicine, Production and Health 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 *postmortem*) and left HL and LD muscle were weighed and frozen (−20 °C) until water holding capacity (WHC), Warner–Bratzler shear force (WBSF) on HL, and proximate composition on LD, were determined. The right HL samples were stored in a ventilated refrigerator at +4 °C overnight. At 48 h *postmortem* the right HL was deboned, and the meat/bone ratio was calculated (Blasco & Ouhayoun, 1996), as well as the HL bone measurements (Section 2.3); then the raw meat was ground and used for heme iron determination.

2.3. Rheological and analytical measurements

Immediately after weighing the carcasses, the color of the 155 right LD muscles was measured on the cross section at the level of the 5th *lumbar vertebra* with a MINOLTA CR-300 colorimeter (light source: D_{65}; L* [lightness], a* [redness] and b* [yellowness]) according to the CIE Lab color system (CIE, 1976). Values corresponded to the average of two measurements on each sample.