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Effects of stray voltage on the physiology of stress, growth performance and carcass parameters in Romane male lambs

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ABSTRACT

The effects of permanent or random exposure to stray voltage on a water trough were evaluated in growing–finishing Romane male lambs between the age of 13 and 19 weeks. Ninety lambs were assigned during two 6-week experimental periods to one of three treatments, with 30 animals in each treatment (15 per experimental period). The treatments were permanent exposure to voltage (PERM, 3.5 V) on the water trough, random exposure to voltage (RAND, 3.5 V, 34 h/week) and no voltage exposure for the control group (CONT). No effects of voltage exposure were observed on production parameters: growth, average daily gain and water intake. The stress physiology seemed to be slightly modified with a lower plasma cortisol concentration at slaughter in PERM lambs compared to CONT lambs ($P < 0.05$) and a higher adrenal medulla weight in PERM lambs compared to CONT lambs ($P < 0.05$). However, no differences were observed between treatments in heart-rate, basal plasma cortisol concentration and tyrosine hydroxylase and phenylethanolamine-N-methyl transferase activities. Carcass yield, temperature and the pH of the *M. longissimus dorsi* were not modified by voltage exposure during rearing. In the good carcass conformation class (R class in EUROP grading scheme), there were fewer fat carcasses (grade 4 of 5) in the PERM and RAND compared to the CONT group ($P < 0.05$). In conclusion, no major effects of voltage exposure were observed in male lambs on production, carcass parameters and stress physiology. Stray voltage could be considered as a mild stressor in growing–finishing lambs.

1. Introduction

Electricity is essential to modern farming techniques and many electrically powered machines are used such as milking machines, automatic feed dispensers, electrically heated watering devices, etc. Leakage of current from this type of equipment, electric and magnetic induction, faulty connections between the electrical circuits and the earth can lead to the undesirable electrical phenomenon called stray voltage (review by Deschamps, 2002). Stray voltage, usually less than 10 V, can produce a low current flowing through farm animals (USDA, 1991; Gustafson, 2003).

In the last few decades, stray voltage has been considered as a possible factor impairing performance in dairy farms and in swine production. Producers and veterinarians have reported impaired animal performance as well as increased health problems and behavioural modifications

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in cows and pigs housed in buildings where stray voltage was detected (review by Hultgren, 1990). So far, studies on stray voltage have been performed primarily in dairy cows and secondarily in pigs (review by Hultgren, 1990). Almost no scientific data are available on the effects of stray voltage in sheep. Moreover, on farms, stray voltage can occur in a random manner and can be unpredictable for the animals (Hultgren, 1990). Predictability of a stimulus or a stressor is important in relation to animal welfare (Désiré et al., 2002; Bassett and Buchanan-Smith, 2007). Indeed, when a stressor occurs in an unpredictable way, it is more stressful for the animal than if the stressor occurs in a predictable way (Quirce et al., 1981) that allows the animal to expect its occurrence and eventually to adapt.

The aim of this experiment was to investigate how random or permanent exposure to voltage on a water trough, during the growing–finishing period, affects stress physiology, growth performance and carcass parameters of male lambs.

2. Materials and methods

This study was conducted during two consecutive years from December to January, in two identical repetitions. Each repetition included a 1-week habituation to pens and to analysis procedures (blood sampling, cardiac strap wearing, weighing) and a 6-week experimental period.

2.1. Animals, feeding and housing

For each repetition, 45 Romane (INRA 401) male lambs, a crossbreed line between Romanov and Berrichon du Cher, progressively weaned from 49- to 67-day-old, were allocated to one of three groups according to age, weight and litter size (averages were, respectively, 90 ± 4.5 days, 28.3 ± 4.71 kg of BW and 2.6 ± 0.73 lambs, mean ± SD, n = 90). The lambs were housed in three similar pens (3.5 m × 4 m, width × length, 15 lambs of the same treatment in each pen) containing a metallic water trough without enamel coating at the end of a stall (only one lamb could drink at any one time), a trough for concentrate and a straw rack. A fourth pen with non-experimental lambs was used as a buffer pen at the entrance of the building. The pens were bedded with straw. A plain wooden barrier 1.5 m high separated each pen from the others. Animals were fed twice daily at 09:00 and 17:00 h (0.7 kg of concentrate per lamb and per meal), and straw was available *ad libitum*. Water and a mineral block were available at all times.

During repetition 1, one lamb of the control group was excluded from the experiment due to health problems (diarrhea and loss of appetite).

2.2. Experimental treatments

The water troughs were electrically insulated from all the metallic parts of the pen. An aluminium plate (0.4 m × 1.2 m, width × length), isolated from the ground, was placed on the floor of the stall. EDF R&D (Electricité de France Research & Development) provided the electricity exposition system allowing application of the chosen alternating (50 Hz) voltage. A voltage of 3.5 V was applied to the water trough to obtain a voltage pathway through the lamb from the muzzle to the four hooves (Fig. 1). The voltage level was determined in a preliminary experiment in order to obtain a current intensity through the animal in the same range as the threshold leading to aversion obtained in a previous experiment in lambs (Duvaux-Ponter et al., 2005).

During 6 weeks, lambs were exposed to a voltage of 3.5 V, either permanently (PERM; n = 30; 15 animals per repetition), or randomly 34 h a week with the duration of exposition varying from 4 to 16 h (RAND; n = 30; 15 animals per repetition). Thirty lambs (15 animals per repetition) were used as the control and were not exposed to voltage (CONT). Pens were randomly allocated to the treatments for each repetition.

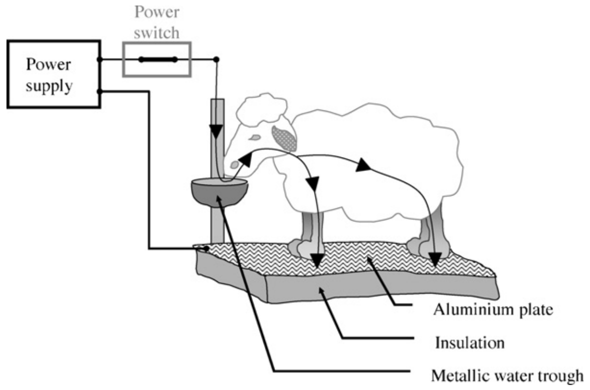

Fig. 1. Simplified diagram of the electrical apparatus used to apply voltage from the muzzle to all hooves of Romane male lambs through a water trough placed at the end of a stall in the rearing pen.

2.3. Production measurements

The animals were weighed once weekly to determine ADG (Average Daily Gain). The quantity of water drunk (called water intake thereafter) was recorded twice daily at 09:00 and 17:00 h for each pen during weeks 1, 3, 4 and 6 of the experiment.

2.4. Carcass measurements

The animals were slaughtered at 134 ± 4.2 days (41.2 ± 6.30 kg of BW, mean ± SD). On two consecutive days for each repetition, with an even number of lambs from each treatment each day, lambs were transported to a commercial abattoir (1 h journey) where they remained 2 h in lairage pens before slaughtering. Temperature and pH of the *M. longissimus dorsi* (at the level of the 12th rib) were measured directly on the carcass using a thermo-sensor and a glass electrode (WTW sentix, WTW, Weilheim, Germany) connected to a digisense pH meter (WTW ph305i, WTW, Weilheim, Germany). Measurements were performed at 30 min, 3 and 24 h after the start of exsanguination (pH at 24 h is called ultimate pH thereafter). Carcasses were weighed 30 min after exsanguination. Carcass yield was calculated using the BW (week 6) and the weight of cooled carcass (98% of carcass weight). According to the EUROP grading scheme (Commission Regulation (EEC) No. 461/93, 1993), conformation was graded by a single assessor into excellent (E), very good (U), good (R), fairly good (O), or poor (P) and fatness was graded into very fat (5), fat (4), covered (3), fairly covered (2), or lean (1).

2.5. Stress physiology measurements

Heart rate measurements were performed at weeks 1 and 3 of voltage exposure, 3 days a week with three animals per treatment recorded each day from 08:00 to 18:00 h. The heart rate monitor used consisted of a watch receiver (Polar® S610i, Polar Electro, Oy, Finland) and two electrodes (Horse Trainer transmitter Polar®, Fleurier, Switzerland) fitted on an elastic belt adjusted to the thorax size of the lambs. The contact between electrodes and skin was improved by small amounts of ultrasound gel smeared on the chest. The heart rate monitor works by averaging the R–R intervals of the QRS electrocardiogram wave complex over 5-s periods as detailed by Karnoven et al. (1984). This procedure was used previously in cows by Hopster and Blokhuis (1994) and in lambs by Roussel et al. (2004). After completion of data collection, the equipment was removed and the Polar® S610i was downloaded by IR communication via a Polar® Interface onto a computer via the software Polar Equine version 4.0 (Polar Electro, Oy, Finland). Cameras were placed above each trough and linked to time-lapse video-recorders. Videos were used to relate the presence of a lamb in the watering stall to its heart rate measurements. This allowed the calculation of the difference between mean heart rate the minute before entering the stall and mean rate in the stall, and the difference between mean heart rate in the stall and mean rate the minute after leaving the stall.

Due to loss of signal and chewing of cables, only part of the heart rate data files could be used (108 drinking sessions for 31 different lambs).