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Risk factors for pre-slaughter mortality in fattening and breeding rabbits

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A R T I C L E I N F O

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A B S T R A C T

Pre-slaughter transportation of rabbits under commercial conditions may influence their mortality, routinely recorded at the slaughterhouse as DOA ('dead-on-arrival' rate). The aim of this study was to identify potential risk factors for DOA, including batch size (number of rabbits loaded), season, stocking density, and transport and lairage duration. A retrospective analysis of 6411 fattening rabbit and 450 breeding rabbit batches transported in a 3-year period to a major abattoir of Northeast Italy was performed. At least one dead animal was recorded in 62% of fattening batches and 14% of breeding batches. Average DOA was 0.08% for fattening rabbits, but in transports with at least one dead rabbit the average DOA was 0.13%. For fattening rabbits, significantly increased DOAs were observed in batches with < 1201 or > 3508 rabbits, mainly during the summer, and at a stocking density higher than 29.3 kg/crate. The highest number of batches at high stocking density was found in winter (61% of all batches). Batches with high stocking density showed a higher DOA even in winter, suggesting that the reduction of space availability does not protect against low temperatures. Regarding travel duration, transports longer than 3 h increased significantly DOA by ≈ 40% compared to transports shorter than 1 h. A lairage longer than 7 h doubled the DOA compared to a lairage shorter than 2 h. The interaction between travel and lairage duration showed that a journey shorter than 1 h can significantly reduce DOA associated with a long lairage. For breeding rabbits, the average DOA in batches with at least one dead rabbit (n = 65), was 1.79%; no significant association with variables was detected.

1. Introduction

Every year, more than a billion rabbits are slaughtered for meat production in the world, with Italy being the second largest rabbit meat producer worldwide and the first one at the European Union (EU) level (Faostat, 2017). Prior to slaughter, rabbits are subject to catching, loading, transportation, unloading and lairage procedures. These are critical phases that can significantly impair rabbit welfare in terms of physiological stress, response to heat, cold, noise and mixing (De la Fuente et al., 2007). Moreover, they can have significant economic implications, affecting carcass and meat quality (Trocino et al., 2003; Lambertini et al., 2006), as well as increased mortality during transport expressed as percentage of dead on arrival (DOA) (Petracci et al., 2010). DOA is an important indicator providing information on pre-slaughter conditions. According to EFSA (2004), rabbits' DOA ranges between 0.1% and 0.4%. Yet, limited data are available about potential risk factors for pre-slaughter rabbit mortality, especially in relation to different rabbit production sectors (i.e. fattening and breeding) and to stocking densities during transport. Petracci et al. (2010) identified temperatures lower than 7.3 °C or higher than 22.6 °C to be risk factors for DOA in fattening rabbits, as well as batches including more than 3681 rabbits and increased journey and lairage duration.

High stocking density may affect rabbit welfare during transportation, especially during long journeys from the farm to the slaughterhouse. While guidelines often indicate average densities for transportation of most domestic animals (Miranda-de la Lama et al., 2014), Regulation (EC) 1/2005 does not define the minimum space for rabbits during transportation. The EFSA (2004) recommends 10 rabbits per crate, with a space allowance of 0.06 m^2/rabbit (for rabbits of 2–3 kg, i.e. 300 cm^2/kg) as the best practice during road transports.

In Italy, regional indications (DGR n. 292 of 23/05/2007) define a maximum stocking density of 140 cm^2/kg (approximately 14 fattening rabbits/crate) in summer and 130 cm^2/kg (approximately 15 fattening rabbits/crate) in winter (Veneto Region, 2007). The aforementioned

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regional legislation refers to fattening rabbits of 2.5–2.7 kg and to breeding rabbits of 3.5–4 kg, placed in a 5225 cm^2 standard crate. No data are available regarding the compliance with such indications and the possible effect of stocking density on DOA. Therefore, this study aimed at identifying potential risk factors for increased DOA in fattening and breeding rabbits, considering variables such as batch size, stocking density, season, travel and lairage duration.

2. Materials and methods

2.1. Data collection

Data for 6861 batches of rabbits slaughtered between the 6th of July 2014 and the 22nd of October 2016 were acquired from the registry of one of the largest rabbit abattoir of Northeast Italy. Specifically, the retrospective analysis was conducted on data of 6411 batches of fattening rabbits (11–13 weeks-old) and 450 batches of breeding animals at the end of production (age was not available). For each batch, the available information included: batch identification number, number of crates, number of animals per crate, average weight of rabbits per crate, stocking density (expressed as kg for each crate), location of origin, and number of dead rabbits per batch. Registration of the time of departure and arrival started from the 8th of June 2015, allowing for the assessment of travel and lairage duration for a subset of batches. Crates used during the study were Super Carfed Mod. 2 P®, Carfed SA, Lugano, Switzerland, with a small door on the short side. The dimensions were 99 × 58 × 26 cm (length × width × height), the inner area was 5225 cm^2.

Batch size (number of rabbits/batch), stocking density of the crate (total kilograms per crate), journey duration and lairage duration were categorized according to data distribution, as proposed by Petracci et al. (2010). Fattening rabbit batches were classified as "low stocking density" (15.1–29.3 kg/crate), "intermediate stocking density" (29.4–32.1 kg/crate), "high stocking density" (32.2–48.2 kg/crate) (Table 1). Batches of breeding rabbits were classified as "low stocking density" (3.0–23.5 kg/crate) "intermediate stocking density" (23.6–29.2 kg/crate), "high stocking density" (29.3–47.5 kg/crate) (Supplementary Table 3).

Journeys were categorised according to astronomical seasons, using the dates of transport recorded in the registry of the abattoir. Ambient temperature and humidity during each day were acquired from ARPAV, (Environmental Protection Agency of Veneto Region, Padova, Italy), meteo-station database. The selected station was located at 12 km from the slaughter plant, and registered daily values (minimum, medium and maximum) of temperature and relative humidity at 2 m height. All procedures and animal care were performed in compliance with Council Regulation (EC) n. 1099/2009 on the protection of animals at the time of killing and Council Regulation (EC) n. 1/2005 on the protection of animals during transport.

2.2. Statistical analysis

The association between season and categories of stocking density was assessed by means of Pearson chi-square test. The number of dead animals per batch during transport was modelled using a Generalised Linear Model (GLM) with negative binomial response distribution to account for overdispersion. Categories of batch sizes, seasons, stocking densities and their interactions were included in the GLM as fixed effects. The journey and lairage durations (expressed in hours) were available for a subset of data (3655 and 3646, respectively) and the effects of these variables on DOA were checked separately using the same statistical approach described above. Associations were expressed as Incidence Rate Ratios (IRRs) with 95% confidence intervals (95% ICs). In breeding rabbits, given the low number of transports with at least one dead animal (14%, 65 out of 450), only descriptive statistics were reported. Descriptive statistics of environmental temperature and humidity during each seasonal period are given as Supplementary Table 1. All statistical analyses were performed using SAS v.9.3 (SAS Institute Inc., Cary, NC).

Table 1
Descriptive statistics and p-values of the associations between Dead-on-arrival (DOA) and transport variables in 6411 fattening rabbit batches. Ref: reference category. Not significant interactions have not been reported. $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

Variable	N. batches	% of batches	DOA%	SE	P
Overall	6411	–	0.077	0.001	–
Batches with at least one dead rabbit	3947	62%	0.125	0.002	–
Batch size[a] (range)					
Very small (< 1201) (ref.)	1327	21%	0.082	0.004	< 0.001
Small (1201–1970)	1031	16%	0.068**	0.003	
Middle (1971–2740)	1453	23%	0.069***	0.002	
Large (2741–3508)	1707	27%	0.069***	0.002	
Very large (> 3508)	893	14%	0.077	0.003	
Season					
Autumn	1664	26%	0.068***	0.002	< 0.001
Summer (ref.)	1889	29%	0.111	0.003	
Winter	1429	22%	0.059***	0.002	
Spring	1429	22%	0.063***	0.002	
Stocking density[a] (range kg/crate)					
Low (15.1–29.3) (ref.)	2310	36%	0.069	0.002	0.0011
Intermediate (29.4–32.1)	1770	28%	0.070**	0.002	
High (32.2–48.2)	2331	36%	0.079**	0.002	
Journey duration categories[b]					
Cat. 1: < 1 h (ref.)	439	12%	0.063	0.004	< 0.001
Cat. 2: ≥ 1 and < 2 h	1298	36%	0.072	0.003	
Cat. 3: ≥ 2 and < 3 h	1001	27%	0.080*	0.003	
Cat. 4: ≥ 3 h	917	25%	0.091***	0.004	
Lairage duration categories[c]					
Cat. 1: < 2 h (ref.)	869	24%	0.051	0.002	< 0.001
Cat. 2: ≥ 2 and < 5 h	958	26%	0.073***	0.003	
Cat. 3: ≥ 5 and < 7 h	799	22%	0.088***	0.005	
Cat. 4: ≥ 7 h	1020	28%	0.099***	0.005	

[a] Batch size and stocking density definition in accordance with Petracci et al. (2010).
[b] 2756 missing records (total records: 6411).
[c] 2765 missing records (total records: 6411).

3. Results

3.1. Fattening rabbits

The average DOA was 0.077%, ranging from 0.0% to 2.0%; 62% of batches (n = 3947) showed at least one dead rabbit. The mean value of DOA for batches with at least one dead rabbit was 0.125%. Results of the statistical analyses are reported in Table 1. Significantly higher values of DOA were observed for "very small" and "very large batches" ($P < 0.001$) as compared to the intermediate categories. Season was significantly associated with DOA ($P < 0.001$): summer showed the highest DOA (mean DOA value = 0.111%) compared to the other seasons. A significant increase in DOA was found in transports with a high stocking density ($P = 0.001$) (Table 1).

Stocking density resulted significantly associated with season ($P < 0.001$), as in winter 61% of transports were had a high stocking density, while in summer they were only 16% (Supplementary Table 2). Notwithstanding this, the interaction term between the two aforementioned factors did not show significant effect on DOA ($P = 0.635$), since a similar trend of DOA among the different stocking densities was observed in all seasons. Both journey and lairage durations had a significant effect on DOA ($P < 0.001$) (Table 1). In particular, DOA showed an increase of 26% in journeys between 2 and 3 h (IRR: 1.261) compared to journeys shorter than 1 h (reference category), and