

THE IMPORTANCE OF SUBCUTANEOUS ABSCESS INFECTION BY *PASTEURELLA* SPP. AND *STAPHYLOCOCCUS AUREUS* AS A CAUSE OF MEAT CONDEMNATION IN SLAUGHTERED COMMERCIAL RABBITS

FERREIRA A. *, MONTEIRO J.M.†, VIEIRA-PINTO M.‡§

*Médica Veterinária Oficial, DGAV, DSVRC, Divisão de Alimentação e Veterinária de COIMBRA, Portugal.

†Médico Veterinário, Diretor técnico da Sumicor, chefe da cunicultura industrial da empresa Coren, Portugal.

‡Departamento de Ciências Veterinárias. Universidade de Trás-os-Montes e Alto Douro. Quinta de Prados, 5000-801 VILA REAL, Portugal.

§Centro de Ciência Animal e Veterinária, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, 5000-801 VILA REAL, Portugal.

Abstract: Subcutaneous abscesses are lesions frequently reported in commercial rabbits. Both at farm and slaughterhouse level, these lesions are responsible for economic losses and a potential decrease in meat quality. The present study was devised to identify the main causes of meat condemnation in slaughtered commercial rabbits and assess the importance of abscess lesions in this domain. For these purposes, 281423 rabbits were evaluated during meat inspection at the slaughterhouse. The results achieved showed that subcutaneous abscesses were the major cause of condemnation, being responsible for the rejection of 1355 (0.48%) rabbit carcasses. The main affected area was the hind limbs (31.37%), followed by the cervical area (23.10%). Microbiological analyses of 27 abscess samples indicated *Pasteurella* spp. as the bacteria mostly isolated (59.3%), followed by *Staphylococcus aureus* (25.9%). These results enable us to advise the industry on the significance of abscesses as an important cause of economic losses, due to meat condemnation during *post mortem* inspection, and highlight the importance of implementing monitoring plans as a way to control this pathological problem.

Key Words: abscess, rabbit, meat condemnation, *S. aureus*, *Pasteurella* spp.

INTRODUCTION

Consumption of rabbit meat has been encouraged by the medical community for its nutritional and dietary characteristics (Hernández, 2012). Portugal is responsible for about 3.5% of European production and 1.8% of world production, corresponding to the ninth place in the world ranking (EFSA, 2005; Xiccato e Trocino, 2007). In 2010, 6 million rabbits were slaughtered in Portugal and the consumption of rabbit meat was estimated to be 1.7 kg per person per year (INE, 2010). The consumers' increasing interest in this meat leads to increased attention to its quality, hygiene and safety. In this context, *post mortem* inspection at the slaughterhouse is a key tool to ensure the safety of the meat and the trust of consumers. Additionally, understanding and determining the causes of commercial rabbit meat condemnation during meat inspection is of extreme importance in order to control and effectively mitigate the etiological factors at the production level (Garcia, 2003).

Subcutaneous abscesses are lesions frequently reported in commercial rabbits. This purulent lesion, which is frequently found on the skin, can be single or multiple and may have varied sizes and locations (Rampin *et al.*, 2008). Multiple or extensive lesions found during meat inspection in the carcass lead to its total condemnation (Tantiñá *et al.*, 2000; Vancraeynest *et al.*, 2006).

These lesions are responsible for economic losses and for a potential decrease in meat quality, both at farm and slaughterhouse level (Rosell *et al.*, 2000). However, in the review of the literature few references were found about the importance of the level of abscesses as a cause of meat condemnation.

Staphylococcus aureus and *Pasteurella* spp. are etiological agents commonly referred to as responsible for suppurated lesions, including subcutaneous abscesses (Tirpude and Batra, 2012). According to Hermans *et al.* (2003), infections with *Staphylococcus aureus* in commercial rabbits, may lead to increased slaughterhouse condemnations. Corpa *et al.* (2009) updated the knowledge on rabbit staphylococcosis, describing the different pathologies that these bacteria may produce in commercial rabbits.

Identification of the specific agents involved in abscess etiology is necessary in order to adequately implement effective prophylactic or treatment strategies that could lead to the reduction of microbiological pressure at farm level.

The aims of this paper are to analyse the importance of subcutaneous abscesses in slaughtered commercial rabbits as a cause of meat condemnation and contribute to the updating of knowledge on the main etiological agents responsible for the occurrence of these purulent lesions.

MATERIAL AND METHODS

From April to December 2012, 65 visits were conducted to one rabbit slaughterhouse in the central region of Portugal. An average of 4330 rabbits were slaughtered per day (roughly 800 rabbits/h; 34 rabbits/min) in this plant. Animals were usually 59 to 74 d old.

Throughout this period, a total of 281423 commercial rabbits were examined during *post mortem* meat inspections at the carcass evisceration point on the slaughter line. Meat inspection was performed according to the definition described in European Regulation (CE) N° 854/2004.

During each visit, all slaughtered animals were analysed and the following data were collected: number of slaughtered animals; number of condemned carcasses (total condemnation) and respective cause; number and cause of partial condemnation for each anatomical region and respective meat loss (kg); number of abscess cases responsible for meat condemnation (total or partial) and respective anatomical region.

To easily register the location of abscess regions, 9 anatomical areas were defined: head, cervical region (ventral), thorax, hind limb, lumbar region, abdominal region, forelimb, umbilical region and genital region (Figure 1).

Samples of purulent material were aseptically collected in sterile containers and sent to the laboratory under refrigerated conditions for further microbiological analysis to identify the etiological agents responsible for the abscess lesions. At the laboratory, microbiological analyses were carried out according to standard techniques. Briefly, abscess specimens were streaked onto Blood Agar and incubated at 37°C for 24 h. Afterwards, the isolates were

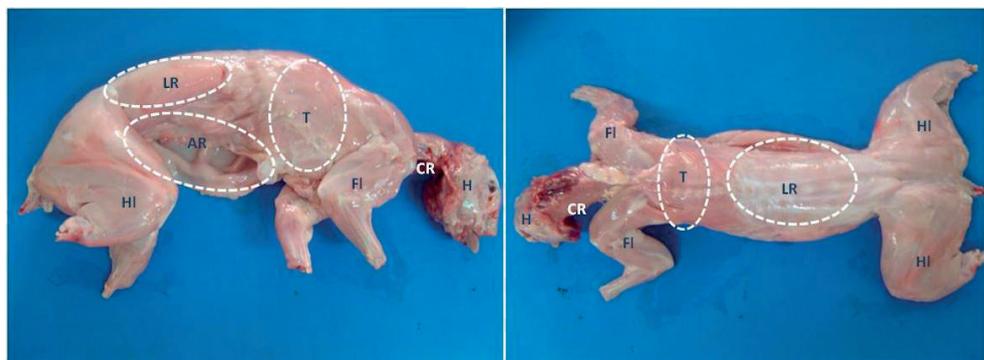


Figure 1: Anatomical areas of abscess lesion location. H: Head, CR: Cervical Region (ventral), T: Thorax, HI: Hind limb, LR: Lumbar region, AR: Abdominal region, FI: Forelimb, UR: Umbilical region and GR: Genital region.

purified and cultured by standard methods for identification of bacterial strains. Isolated organisms were identified by Gram staining technique and by biochemical tests, rapid kits, and other standard methods (Murray *et al.*, 1999).

A total of 30 samples were collected on rabbits from 15 different farms. The identification of the farm, as well as the anatomical region of the abscesses, was registered.

RESULTS AND DISCUSSION

During the study period, 281423 commercial rabbits were examined during *post mortem* meat inspections and 3063 (1.09%) were condemned for human consumption (Table 1). This result is equivalent to that previously reported by Piccirillo *et al.* (2008) in Italy. Unfortunately, it is not possible to compare the present results with other national data because, to the best of our knowledge, this is the first study in Portugal to report the level and causes of commercial rabbit condemnation at slaughterhouse level.

The condemnation level observed in this study resulted in the loss of 3928 kg of meat, which corresponds to approximately 6678 Euros (considering 1.7 Euros/kg meat sold at slaughterhouse). From the 3063 carcasses condemned for human consumption, several causes of total condemnation were registered (Table 2).

As presented in Table 2, the main cause of total condemnation was related to the presence of abscess lesions (44.2%). Piccirillo *et al.* (2008) also referred to abscesses as representing 37.7% of the recorded lesions observed during meat inspection. However, these results cannot be directly comparable because the cited authors did not associate the presence of abscesses with the level of carcass condemnation.

Results from *post mortem* meat inspection can point to specific sanitary problems at farm level, as is the case of the abscess and pneumonia lesions observed in this study. Several authors previously emphasised the collection of data related to pathological lesions detected during meat inspection at slaughterhouse as an important epidemiological tool for the evaluation of sanitary profile at farm level and to verify the efficacy of prophylactic and therapeutic interventions (Antia and Alonge, 1982; Kofer *et al.*, 2001; Vecerk *et al.*, 2003)

Nevertheless, as previous presented in Table 2, it is often only possible to identify unspecific pathological lesions: abnormal coloration (which can be related to *ante mortem* febrile processes) and cachexia (without evidence of a particular pathological process), which may also entail important levels of condemnation (44.7%, in this study). In these cases, if necessary, additional tests (e.g. serology, microbiology) may be performed to reach an etiological diagnosis.

In this study, abscess lesions were responsible for the decommissioning of 0.49% of carcasses (1355/281423), corresponding to a loss of approximately 1741 kg of meat. The anatomical area affected with these lesions was registered in the corresponding condemned carcasses (Table 3) in order to improve understanding of the occurrence of subcutaneous abscesses. The main areas affected by abscess lesions responsible for carcass condemnation were the hind limbs (31.4%), followed by the cervical region (ventral) (23.1%), thorax (13.4%) and the lumbar region (11.9%).

Table 1: Monthly distribution of the number of slaughtered commercial rabbits and the respective level of total condemnation during meat inspection.

Month	Slaughtered rabbits (No.)	Condemned carcasses No. (%)	Condemned Meat* (kg)
April	21375	201 (0.94)	258.28
May	43836	427 (0.97)	548.70
June	40937	567 (1.39)	728.60
July	44979	444 (0.99)	570.54
August	10447	124 (1.19)	159.34
September	46193	489 (1.06)	628.36
November	25587	330 (1.29)	424.05
December	48069	481 (1.00)	618.08
TOTAL	281423	3063 (1.09)	3928.24

*Considering that the average body weight found was 1.285 kg.

Table 2: Causes of total condemnation of commercial rabbit carcasses.

Cause of condemnation	No. (%)
Abscess lesions	1355 (44.2)
Abnormal colouration	718 (23.4)
Cachexia	652 (21.3)
Pneumonia	208 (6.8)
Faecal contamination	58 (1.9)
Arthritis	21 (0.7)
Traumatic injuries	18 (0.6)
Hidroemia	17 (0.6)
Icteric colour	11 (0.4)
Purulent metritis	2 (0.07)
Cystitis	2 (0.07)
Enteritis	1 (0.03)
Total number of condemnations	3063 (100)

on the farm. For instance, according to the authors' experience, the presence of subcutaneous abscesses in the ventral cervical area may suggest occasional damage to the feeding or watering equipment. Moreover, some of the forelimb abscesses can be a secondary effect of infection after injection, as previously presented by Rosell *et al.*, (2000). Considering these facts, the authors suggest that these data should be included in any monitoring programme to be registered in the slaughterhouse.

According to Hermans *et al.*, (2003) and Piccirillo *et al.*, (2008), animal fighting, which can be related to increased animal density, can promote abscess formation. In this case, in our opinion, abscess lesions detected at slaughterhouse level probably do not have any specific anatomical distribution and may occur on different parts of the carcass, like the ones observed in the genital region (only observed in males).

To obtain more precise information concerning meat losses for reasons of condemnation, the number, weight (kg) and causes of carcasses partially condemned during meat inspection were recorded during the study period. The results are summarised in Table 4.

In the present study, a total of 920 (0.35%; 920/281423) carcasses were partially condemned during meat inspection. All of these carcasses were subsequently redirected to the slaughterhouse cutting room to be cut and packaged, allowing the recovery of the unaffected part of the carcass for human consumption, avoiding increased losses. If this procedure was not available in the slaughterhouse, the condemnation rate (total carcass) would have increased from 1.09% up to 1.41%.

Table 3: Anatomical area affected with abscess lesions in condemned carcasses.

Anatomical area	Abscesses lesions No. (%)
Hind limb	425 (31.4)
Cervical region (ventral)	313 (23.1)
Thorax	178 (13.1)
Lumbar region	162 (11.9)
Abdominal region	135 (9.9)
Forelimb	98 (7.2)
Umbilical region	29 (2.1)
Genital region	13 (0.9)
Head	2 (0.2)
Total	1355 (100)

According to Ferrián *et al.* (2010) for the development of subcutaneous abscesses to occur, it is necessary to break the skin's integrity, whereupon colonisation by bacteria from the environment or from animals takes place. This means that first the presence of factors responsible for the occurrence of wounds is necessary, followed by the presence of bacteria to cause the infection. The presence of bacteria is mainly related to farm hygiene management or to the sanitary profile of the animals (asymptomatic reservoirs). The occurrence of wounds could be related to several etiologies (e.g. traumatic infections resulting from fighting, injections, equipment damage) and can be favoured by stress, high temperatures, humidity and the concentration of ammonia (Rosell *et al.*, 2000; Hermans *et al.*, 2003; Coudert *et al.*, 2006; Ferrián *et al.*, 2010).

In some circumstances, the identification of the affected area can be useful to understand the risk factors present

The main affected areas subjected to partial condemnation were the hind limb (40.3%) followed by the head (31.6%) and the forelimb (25.8%). For all of these parts, abscess lesions were also the main cause of condemnation. A total of 629 abscess lesion cases were registered, corresponding to 68.4% of the partial condemnations causes. At present, according to our knowledge, this is the first study that presents the quantification and causes of partial condemnation in rabbit slaughterhouses that allows us to estimate the importance of this economic loss.

Analysing the results obtained in this study, it is possible to conclude that, in fact, abscess lesions were the main cause of partial and total condemnation, which

Table 4: Number, weight (kg) and causes of partially condemned carcasses during meat inspection.

Month	Head and cervical region		Forelimb		Hind limb			1/4 CAR	1/2 CAR	Kg	TOTAL Affected Carcasses
	ABC	TRA	ABC	ART	ABC	TRA	ART	TRA	TRA		
April	27	13	22	5	14	14	3	2	0	15.04	100
May	71	8	24	5	32	31	3	5	1	29.98	180
June	36	7	35	3	27	26	11	5	0	25.3	150
July	31	7	22	4	36	17	6	1	0	19.86	124
August	3	1	2	0	2	4	0	1	0	3.30	13
September	28	3	35	1	40	16	0	1	0	21.04	124
November	26	3	25	1	18	13	1	3	0	15.77	90
December	22	5	50	3	30	25	2	2	0	21.58	139
TOTAL	244	47	215	22	199	146	26	20	1	152	920
	(291; 31.6%)		(237; 25.8%)		(371; 40.3%)			(2.2%)	(0.1%)		(100%)

ABC: Abscess; TRA: Trauma; ART: Arthritis; CAR: Carcass.

emphasises the importance of this pathological process as an important cause of economic loss in the rabbit meat production chain.

Bearing in mind the etiologies of the abscesses, we may consider these lesions as potential indicators of animal welfare at farm level. Also, in this context (animal welfare evaluation), traumatic lesions, which were the second most important cause of partial condemnation (23.3%; 214/920), can also be considered an important indicator of animal welfare during capture, transportation and hanging (in the slaughterhouse). In this study, these traumatic lesions were mainly observed in the hind limbs. In this study, these limbs were also frequently affected by abscesses (Table 3 and Table 4).

Of the abscesses associated with total condemnation, a total of 30 samples were collected for microbiological analyses to identify the main etiological agent responsible for this pathological process. From those samples, only 27 allowed us to obtain microbiological results. The results are summarised in table 5.

In the present study, *Pasteurella* spp. was the bacteria most frequently isolated (59.3%) from subcutaneous abscess lesions, followed by *Staphylococcus aureus* (25.9%). These results do not agree with those previously obtained by Corpa *et al.* (2009), who isolated *S. aureus* from 78.5% of abscesses in does. Another study on the evaluation of microorganisms isolated from abscesses in slaughtered animals was developed by Menes *et al.* (1984). The authors identified *Staphylococcus* species in 63.4% of 112 abscesses observed during inspection of slaughtered animals (sheep, cattle, pigs and goats). From those, 42.3% were classified as *S. Aureus*; the identification of the bacteria involved in the abscess etiology is of major importance to implement the most effective antibiotic therapy at the farm level.

Table 5: Location of abscesses and etiological agents isolated.

Abscesses' location	Etiological agents isolated				Total
	<i>S. aureus</i>	<i>Pasteurella</i> spp.	<i>T. pyogenes</i>	<i>Bacillus</i> spp.	
Hind limb	2	4	1	1	8
Abdominal region	2	-	-	-	2
Cervical region (ventral)	1	9	1	-	11
Thorax	1	2	1	-	4
Lumbar region	1	1	-	-	2
Total	7 (25.9%)	16 (59.3%)	3 (11.1%)	1 (3.7%)	27 (100%)

S. aureus – *Staphylococcus aureus*; *T. pyogenes* – *Trueperella pyogenes*.

Rosell *et al.*, (2000); Hermans *et al.*, (2003) previously reported that suppurative inflammations are the consequence of traumatic infections (insect bites, scratches by other rabbits, wounds caused by abrasive cage floors) (and, according to Okerman, (1988) and Rosell *et al.*, (2000), the main microorganisms responsible for them are *Staphylococcus* spp. (mainly *S. aureus*), *Streptococcus* spp. and *Pasteurella multocida*.

Staphylococcus aureus is a bacterium that can be found in the skin or mucous membrane of healthy rabbits, while *Pasteurella* spp. colonisation is more related to the respiratory tract. From there, these bacteria can contaminate the environment or infect other animals (Boucher and Nouaille, 1996; Badiola, 2000).

As previous presented in table 5, *Pasteurella* spp. was isolated from 9 (81,8%) of the 11 cervical (ventral) region abscess samples, which indicates this anatomical area as potentially more susceptible to this specific infection. This result is in agreement with Rosell (2000), who states that abscesses located in the cervical area are mainly related to *Pasteurella multocida* infection. According to Badiola (2000), feeding and watering equipment can be contaminated with nasal discharge containing *Pasteurella* spp., pointing out their importance as potential sources of infection for abscess lesions in the cervical region (ventral). These results constitute important information for production vets to further their understanding of this problem, and in implementing effective corrective measures that should be focused on reducing risk factors. Since this study was based on a small number of samples, the authors would like to underline the importance of carrying out additional research on this topic to validate this hypothesis, which could then be used as a pathological indicator.

CONCLUSIONS

Abscesses were the major cause of meat condemnation in commercial rabbit carcasses at slaughterhouse level, being responsible for important economic losses. In the present study, abscess lesions were mostly found in the hind limbs. The main etiological agents isolated from abscess samples were *Pasteurella* spp. followed by *Staphylococcus aureus*. The results observed in this study emphasise the importance of abscess monitoring in the slaughterhouse as an aid to the implementation of best management practices at farm level.

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