EFFECT OF TRANSPORT TIME AND SEASON ON ASPECTS OF RABBIT MEAT QUALITY[1]

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Background

The events involved in the transport chain, and other related factors, may induce stress in rabbits (Jolley, 1990) and can affect aspects of meat quality (Masoero et al., 1992). Little is known about the effect of transport on rabbit meat texture or colour. Ultimate meat pH is the most commonly measured parameter in studies that consider ante-mortem effects on meat quality. However, while it is clear that even travelling short distances can reduce live weight (shrinkage), decrease glycogen reserves and increase meat temperature (Jolley, 1990), this is not always reflected in changes in ultimate pH. There may be no effect when transport is only a slight stress and the animals are in good condition. The relationship between initial muscle glycogen content and ultimate pH is only linear at very low levels of glycogen. Thus, they are not lowered enough to have a substantial effect on the ultimate pH, especially when the animals can recover during lairage. Changes in meat texture and colour with respect to ante-mortem stress have been considered, but normally the effect of transport time has been mixed with other confounding factors (e.g., breed, production system, nutrition, etc.). In Spain, transport of commercial rabbits to the abattoir is relatively short, typically less than 3 hours. Recently, a report by the Scientific Committee on Animal Health and Animal Welfare has proposed important limitations on transport time and the European Parliament has suggested decreasing all journeys for all species to less than nine hours. Although these measures may improve animal welfare, it remains unclear whether imposing them on a commercial level will also improve meat quality. This fact is even more important in commercial rabbits where little information is available.

Objectives

The aim of this study was to analyze whether transport times of up to 7 hours can have a significant effect on instrumental meat quality traits in rabbits. Due to the characteristics of the Spanish climate, with very hot summers and cold winters, replicates were performed in two seasons. We also considered the effect of position on the truck as a factor which could affect meat quality.

Materials and methods

We analysed the instrumental quality of meat from 156 rabbits that were transported by road, together with other non-target animals, for 1h or 7h in winter and summer with three replicates each. The average temperature during transport was recorded every 5 minutes with a Testo thermometer at the level of the study animals. The average temperatures were 11ºC ± 3 and 28ºC ± 2 in winter and summer, respectively. Three main effects were considered: transport time, season and position on the truck (top, middle or bottom) in a multi floor cage rolling stand (MFRS). For each season and journey time, 36 animals were selected (12 in each position). The stocking density during the transport was 360 cm^2 per animal. The cage size was 57 x 57 x 25 cm, in MFRS & Sañudo, 2001). For texture meat analyses, longissimnus dorsis muscles were vacuum packaged and frozen at –18ºC. The compression and Warner-Bratzler (WB) analyses were performed on sample slices as in Campo et al. (2000) with an Instron with 12 cages each. The total capacity of the truck was 2400 rabbits per trip. The rabbits were slaughtered after 3 h of lairage in the same MFRS. Average carcass weight was 1192.50 g (±121). Carcasses were chilled under commercial conditions at 0ºC for 24 h. The meat pH was measured at 24 h post-mortem on the lumbar region with a Crison 507 electrode. Sixteen additional rabbits were taken randomly to study the proportion of muscle, bone and fat of the carcasses by dissection in the lab. The longissimus dorsi was removed from both sides and the right side was sliced into three steaks for instrumental analysis. Water holding capacity (WHC) was measured 24 h after slaughter and expressed as press juice using the Grau and Hamm method (Cañeque 4301. Briefly, thawed steaks (internal

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temperature 17-19ºC) were cut transversally to be studied either as raw or cooked meat. Texture of the raw meat was analysed using a modified compression device that avoids transversal elongation of the samples. The stress was assessed at 20% (P20), 40% (P40), 60% (P60) and 80% (P80) of the maximum compression (MS). Meat was vacuum packaged prior to cooking in a water bath at 75ºC until the internal temperature reached 70ºC. Samples (1 cm^2 cross-section) were cut with muscle fibres parallel to the longitudinal axis of the sample. Maximum load (ML) and toughness (TO) were assessed in heated meat using a Warner Bratzler device, shearing until breaking the samples (10 mm wide and 10 mm thick). The sample gauge was 10 mm, gauge length 30 mm, load cell 100 kg (minimum load level 0.001 kg), crosshead speed 150 mm /min (high extension limit 30 mm) and sampling rate 20 points/second. Meat colour was measured in the reflectance spectrum every 10 nm from 400 to 700 nm using a Minolta (2002) reflectometer-colorimeter. Measurements were taken from the surface of a slice of meat from each animal transported. Slices were freshly cut at 24 h post-mortem and measured after 24 h blooming. Each slice was placed at 4ºC on individual plastic foam trays and wrapped with an O_2 permeable film without touching the sample. The L*a*b* values were taken using the standard illuminant D65 and 10º standard observer for all measurements. The data were analysed using the least square methodology of the GLM procedure of SAS (SAS, 1988), fitting a three-way model including the fixed effect of transport time (2 levels), season (2 levels) and position on the stand cages (3 levels) plus the interaction effect.

Results and discussion

The average percentage composition of the left middle carcass was 75.31 (±2.7) muscle, 4.62 (±1.09) fat and 16.39 (±1.8) bone (n=16 animals). The significance of the main effects is presented in Table 1. The effect of position on the truck was not significant. Season and journey time had significant effects on several instrumental meat quality parameters. The interaction between time and season was only significant for Warner Bratzler variables.

The least square means for all the instrumental variables are presented in terms of season and journey time in Table 2. The parameters fell within the range of good quality meat. Similar results were found by Trocino et al. (2002) and Xicato et al. (1994) in their studies on rabbit transport. Transport time did not affect pH24, WHC or Warner Bratzler texture parameters. All the texture parameters evaluated by compression were significantly affected by journey time ($p \leq 0.001$). In general, the values were higher after short journeys. Transport time slightly affected colour parameters, and a* was significantly higher after long journeys ($p \leq 0.05$), especially in winter. Other studies (Jolley, 1990; Masoero et al. 1990 and Dal Bosco et al., 1997) have found that pH increase after longer journeys.

Season had a significant effect on all the response variables, with the exception of compression at 80% and maximum stress. The pH 24 values were significantly higher in winter than in summer, but always below 6. The same situation was observed for WHC. Some authors have found that transport affects WHC (Trocino et al., 2002; Jolley, 1990). Nevertheless this parameter could be affected by the treatment applied (Ouhayoun & Dalle Zotte, 1996). All texture variables analyzed by Warner Bratzler were higher in winter than in summer. The same situation was true for 20% compression. The colour parameters were all affected by season. Redness was higher in winter than in summer but the opposite occurred for yellowness. Lightness varied less, but the difference was still significant ($p \leq 0.05$) between long journeys, increasing for summer trips. There was a significant interaction between journey time and season for texture traits evaluated by Warner Bratzler (Figure 1). According to our results, instrumental meat quality could be affected by the multifactor stressors involved in the transport process. Values for meat colour were similar to Trocino et al. (2002), but higher than Jolley, 1990. Dal Bosco et al. (1997) found that meat from animals from short journeys had significantly higher L*.

Few studies have considered the effect of transport on instrumental measurements of meat quality in commercial rabbits. Under the controlled commercial conditions of this work, transport time of up to seven hours significantly affected the instrumental quality of rabbit meat as measured by a modified compression device, which reflects the mechanical resistance of the myofibrillar structure (P20) and connective tissue strength (P80). No differences were found in ultimate pH between transport groups, which conditioned the lack of variation in other variables such as WHC and other texture parameters assessed by Warner Bratzler shear device and the slight effect of redness.

Season affected almost all the variables, but it was not completely independent from the effect of transport time. Even when the effect of journey time was not significant (for WB variables), there was a significant interaction between transport time and season, with the worst texture values after short journeys in winter and long journeys in summer. Independently of journey time, season did not have an effect on meat quality. In summary, transport time had an effect on instrumental meat quality in terms of compression and a slight effect on colour. Within the range of transport times analysed, there were no significant changes in pH, which is the main parameter used to judge meat quality on an industrial level. Finally, position within the multi floor cage stand did not affect instrumental meat quality.

Conclusions

The general conclusion of this study is that, even under optimum commercial conditions, rabbit meat quality could be affected by the multiple stressors involved in the transport process. Transport affected several measures of meat quality and this effect depended on the season of the year.

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Table 1. Summary table of the significance of the main effects and their interaction for instrumental meat quality parameters.

Response Variable	Main Effects in the Full Model						
	Season	**T**ime	**P**osition	**S*T**	**S*P**	**P*S**	**S*T*P**
pH24	***	NS	NS	NS	NS	NS	NS
Water holding capacity	***	NS	NS	NS	NS	NS	NS
Warner-Bratzler							
Shear force (Kgf)	***	NS	NS	***	NS	NS	NS
Toughness (Kgf/cm2)	***	NS	NS	***	NS	NS	NS
Compression							
C20 (20%)	***	***	NS	NS	NS	NS	NS
C80 (80%)	NS	*	NS	NS	NS	NS	NS
Maximum Stress (N/cm2)	NS	***	NS	NS	NS	NS	NS
Colour							
L* (lightness)	*	NS	NS	*	NS	NS	NS
a* (redness)	***	*	NS	NS	NS	NS	NS
b* (yellowness)	***	NS	NS	NS	NS	NS	NS

The levels of significance were * p<0.05 ** p<0.01 *** p<0.001. **S**eason refers to summer or winter. **T**ime: journey time (1 hours or 7 hours). **P**osition: position in the multi floor cage rolling stand (top, middle or bottom cages) during transport.

Table 2. Least square means (±S.E.) of instrumental meat quality parameters in summer and winter and after two different transport times (1 h or 7 h).

Response Variable	Summer (1)		Winter (2)	
	1 h	7 h	1 h	7 h
pH24	5.75±0.02a	5.77±0.01a	5.97±0.03b	5.90±0.02b
Water holding capacity	12.61±0.45a	12.12±0.44a	14.93±0.45b	14.57±0.42b
Warner-Bratzler				
Shear force (Kgf)	0.61±0.04a	0.72±0.04a	1.04±0.03b	0.91±0.04c
Toughness (Kgf/cm^2)	0.25±0.01a	0.31±0.02b	0.42±0.02c	0.31±0.02b
Compression				
P20 (20%)	10.65±0.34a	9.69±0.33b	12.32±0.34c	11.39±0.35a
P80 (80%)	16.66±0.56a	17.01±0.57a	17.36±0.52a	14.92±0.51b
Maximum stress (N/cm^2)	21.90±0.62a	20.61±0.0.61a	24.02±0.63b	20.74±0.60a
Colour				
L* (lightness)	58.46±0.34ab	59.36±0.36b	58.44±0.33ab	57.95±0.31a
a* (redness)	2.34±0.21a	2.49±0.20a	3.45±0.22b	4.19±0.26c
b* (yellowness)	4.09±0.25a	4.18±0.27a	2.92±0.20b	3.18±0.22b

Different letters in the same row indicate significant differences ($p \leq 0.05$)

Figure 1. Interaction effect between transport time (short or long) and season (winter or summer) for the Warner Bratzler texture traits.