Report from the study "How is skin quality and carcass weight of lambs affected by lariage overnight at abattoirs?"

Introduction

Ongoing structural rationalizations have led to closure of abattoirs followed by prolonged journeys and a significantly increasing proportion of animals staying overnight at the abattoirs. In 2015, 255 501 commercial sheep and lambs where slaughtered in Sweden (Därth, 2016). A study from the National food administration (Livsmedelsverket) made on 12 large-scale Swedish abattoirs showed that about 60% of the lambs slaughtered in Sweden is in lairage overnight before slaughter (Berg & Axelsson, 2010).

In the literature, some studies conclude that lairage time after transport potentially allows the animal to rest, renew muscle glycogen concentrations and reduce dehydration of body tissues and carcass weight loss (Jacob et al., 2006; Liste et al., 2011). Other authors think that the lairage environment itself may inhibit the ability of the animals to rest and recover from the effects of feed and water restriction (Jarvis et al., 1996), and long lairage time is associated with a drop in carcass and meat quality (Warner et al., 1998; Gallo et al., 2003). The discrepancies in these results indicates that more research is needed to further investigate and establish a proper waiting time before slaughter with respect to animal welfare and meat and skin quality.

Background

Carcass weight and meat quality are important for both producers and abattoirs. Research has been conducted in several countries to study how transportation and lairage time affect animal welfare indirect by measuring carcass weight and meat quality (Gallo et al., 2003; Liu et al., 2012). A longer transportation time has been shown to affect the meat quality negatively (Gallo et al., 2003). One major influence of pre-slaughter handling on meat quality is through the potential effect on muscle glycogen stores. After death, glycogen in the muscles is converted to lactic acid. When the concentration is adequate this leads to acidification of the meat from an initial pH of about 7.0 to a final pH of about 5.5. If muscle glycogen is depleted before slaughter through stress and/or lack of feed or physical strain associated with agonistic behaviour like mounting and fights, then the extent of acidification is limited and the final pH reached is much higher than the ultimate 5.5. If the final pH is 5.8-6.0 the meat tends to have an abnormal colour and a shortened shelf life. Above 6.0 it is very dark, and above 6.5 extremely dark and difficult to market. Commonly, meat with pH of 6 and above is referred to as dark, firm and dry (DFD), which means that the meat has a firm texture, looks dry and produces little or no exudates when cut (Warriss, 1990).

Weight loss after lairage has been found in lambs. Liu et al. (2012) found higher weight loss in lambs after 12, 24 and 48 hours in lairage compared to lambs that had been in lairage for 0, 2 or 6 hours before slaughter. However, when it comes to carcass and meat quality, only the 48 h group showed significantly lower carcass weight and higher final pH compared to the 0 h group (Liu et al., 2012). A disadvantage with lairage for a longer period of time is that even though the animals are offered feed and water at the abattoir it is not sure that they eat and drink. Even though sheep were dehydrated, Knowles et al. (1993) found that they did not drink readily, especially from an unfamiliar water source, after transportation. Also Liu et al. (2012) conclude that lairage at the slaughterhouse can cause dehydration in

lambs even though they have had access to water. Further, urine samples were collected monthly over one year at two Australian abattoirs to measure the hydration status of lambs. Status of hydration was estimated through urine osmolality and it was observed that half of the lambs had values indicating on dehydration (Jacob *et al.*, 2006). An indicator of dehydration is the pliability of the skin. When the animal or the carcass is dehydrated the skin is harder to remove from the carcass. This makes the work harder when removing the skin from the carcass. The skins water content is normally regulated by colloidal osmotic pressures that are controlled by glycosaminoglycan connected to the collagen fibres. But when the skin is dehydrated the matrixes of the collagen fibre in the skin strengthen. The collagen fibrils get more compact and it gets more difficult to separate them apart (Gregory, 1998). In a small study of water content in cattle skin all animals lowered their amount when dehydrated. The water content of the skin reduced in average during dehydration from 70.6 to 65.8%. The Oxen lost in average 1,336ml water when dehydrated and the calves 315ml from the skin (Bianca, 1968).

The results indicate that the greater loss of carcass weight after longer periods in lairage would also be of economic importance. Farmers are paid on the basis of carcass weight and this loss is therefore borne by the farmer, and to some extent of the abattoir. In addition, the increases in muscle pH and the losses of live weight indicate that the longer journey and longer periods in lairage had adverse effects on the animals' welfare (Gallo et al., 2003).

There are, however, studies that show positive effects with lairage at the slaughterhouse. They conclude that lairage time after transport potentially allows domestic animals to rest, renew muscle glycogen concentrations and reduce dehydration of body tissues and carcass weight loss (Jacob et al., 2006; Liste et al., 2011). del Campo et al. (2010) draw the same conclusions about stress that there are many factors that influence whether staying overnight at the abattoir leads to positive or negative effects on meat quality and carcass weight, such as differences in animal experience (handling and feeding system), temperament and breed (genetic affiliation), handling procedures from farm to death, transport duration and conditions, facilities of the abattoir, weather conditions, and/or cumulative effects of the different factors (del Campo et al., 2010). Further, stressors appear to be additive and multiple stressors in the pre slaughter period will result in a greater elevation of final muscle pH than one single stressor alone (Bray et al., 1989).

To summarise, reported findings about the effects of lairage time conflict and the conditions at the abattoir have big influence on the results. Pre-slaughter handling can affect both carcass and meat quality. Losses in carcass yield are caused by both mobilisation of tissues to provide energy for maintaining the vital functions of the body and the dehydration which often accompanies the inevitable period of food and water deprivation together with the stress of transport. As far as we know, no study has been conducted investigating the animal welfare implications of lairage time at the abattoir under Swedish conditions.

Aim

The overall aim of the study was to find out how lambs is affected lairage stay overnight at the abattoir. The question was whether the animals that spent the night at the abattoir have a lower carcass weight and poorer skin quality than if they are slaughtered on the day of arrival. If so, it could lead to lower revenues for producers, lower utilization of slaughterhouse resources and deterioration of product quality.

Materials and methods

Several farmers were contacted and although all of them thought it was very important to investigate whether lairage overnight at the abattoir affect the carcass weight or not, in the end it was only one that could participate. Almost none used to weight the lambs before slaughter and those who did had an agreement with the abattoir that none of their animals should be in lairage overnight. Hence, data was collected from a commercial farm with just over 340 ewes. The data came from lambs sent to slaughter from June 2011 to October 2014. The main breeds used where Finull, Gotland, Suffolk, Texel and crossbreeds between those. The majority of the lambs was weight around two days before slaughter. The lambs where reared either out on pasture (49 %) or indoors (51 %) before sent to slaughter. In total 693 lambs were included in the study and of those 435 were in lairage overnight at the abattoir.

For each animal the following data was obtained: if it was slaughtered from stall or pasture, live weight prior to slaughter, which abattoir, if the animal was in lairage overnight or slaughtered on the day of arrival, carcass weight, conformation and fatness. All animals in the study were slaughtered on the same abattoir, hence there is no or little difference in transportation time. It was not possible to get breed or gender for all lambs, therefore is the importance of these parameters in this context not investigated. In addition, the farmer had no information about any skin damages.

Statistical analysis

To evaluate the main effects of lairage and rearing method on the measured parameters, the acquired data were subjected to statistical analysis using the General Linear Model procedure in Mintab. For the different parameters, LSMeans were calculated which adjust for the differences in distribution of "weight-out" in the different groups. For pairwise comparisons, Tukey's test was used. Differences were considered significant if $p<0.05$.

Results

In total 693 lambs were included in the study of which 63 % were lairaged overnight at the abattoir. Almost half of all lambs in the study were reared indoors, 51% and 49% on pasture. There were no differences in live weight, carcass weight or dressing (carcass weight as a proportion of live weight) whether the lambs had stayed overnight or not, there were however significant differences in both live weight (42.7 kg vs. 41.9 kg; $p<0.05$) and dressing (41.2% vs. 42.1%; $p<0.01$) between lambs reared on pasture and those reared indoors. In Table 1, the results are shown for lambs reared on pasture and indoors, respectively.

Of the lambs reared on pasture, 70% were in lairage overnight and 30% were slaughtered the same day as arrival at the abattoir. No significant differences could be seen between live weight, carcass weight, confirmation score or fat score. There were, however, a somewhat lower carcass weight from the animals slaughtered on the same day which led to a lower dressing percentage from these animals ($p<0.05$) (Table 1).

Of the lambs reared indoor, 56% where lairaged overnight and 44% were slaughtered upon the day of arrival. Despite a higher live weight ($p<0.01$) of those that stayed overnight, the carcass weight was the same of both groups which resulted in a higher dressing ($p<0.001$) of lambs that were slaughtered on the day of arrival. Conformation score did not differ significantly between lairage or not but lambs in lairage had on average a lower fat score ($p<0.01$) (Table 1).

Table 1. Live weight, carcass weight, dressing, conformation score and fat score of lambs reared on pasture and indoors, respectively. Standard deviation in parenthesis.

	No lairage	Lairage	Significances[1]
Lambs reared on pasture			
Number	101	237	
Live weight (kg)	42.8 (3.1)	42.8 (3.4)	n.s.
Carcass weight (kg)	17.3 (1.5)	17.7 (1.7)	n.s.
Dressing (%)	40.4 (2.8)	41.3 (2.9)	*
Conformation score[2]	7.4 (1.0)	7.6 (1.4)	n.s.
Fat score[3]	6.9 (1.0)	6.6 (1.1)	n.s.
Lambs reared indoors			
Number	157	198	
Live weight (kg)	41.4 (3.3)	42.5 (3.7)	**
Carcass weight (kg)	17.8 (1.5)	17.6 (1.5)	n.s.
Dressing (%)	43.0 (3.0)	41.5 (3.5)	***
Conformation score[2]	7.8 (1.0)	7.6 (1.3)	n.s.
Fat score[3]	7.0 (1.1)	6.5 (1.4)	**

[1]NS, non-significant at p≥0.05; *, significant at p<0.05; **, significant at p<0.01; *** significant at p<0.001

[2] According the EUROPE-system where 1=P-, 2=P, 3=P+, 4=O-, 5=O, 6=O+; 7=R-, 8=R, 9=R+, 10=U-, 11=U, 12=U+, 13=E-, 14=E and 15=E+.

[3] According the EUROPE-system where 1=1-, 2=1, 3=1+, 4=2-, 5=2, 6=2+; 7=3-, 8=3, 9=3+, 10=4-, 11=4, 12=4+, 13=5-, 14=5 and 15=5+.

Discussion

The study was initiated due to some farmers notion based on the high prevalence of lambs staying overnight at the abattoir. The farmers was further concerned about economic losses for the lambs that were in lairage overnight but also for the welfare of their animals. Of the lambs included in this study, 63% were in lairage overnight at the abattoir, which confirms previous findings under Swedish conditions (Algers et al., 2006; Berg & Axelsson, 2010).

When looking at all lambs, there were no differences in average live weight whether they had been in lairage overnight or not, which indicates that the groups of lambs in the study were relatively even and had a good comparability. However, irrespective of lairage or not, the group reared on pasture had a higher live weight (p<0.01) than the group reared indoors. This could be an indication that the two rearing systems had different effects on the growth of lambs. It is well known that lambs reared on pasture need longer time to fulfil the requirements for good carcass conformation and therefore are older when being sent to slaughter. The older the lamb is when being slaughtered, a lower dressing percentage can be seen. Management such as age when sent to slaughter, different feeding regimes, breeds used, gender and previous experience could possibly affect the result. All those affect the animals' response to a stressful stimuli.

Lairage overnight resulted in significant differences in dressing percentage between animals that had been in lairage and those who were slaughtered the day of arrival. The result were however different for lambs reared on pasture compared to lambs reared indoors. When looking at the lambs reared on pasture, the dressing was 1% higher for the animals that stayed overnight (p<0.05; Table 1) while it was the opposite (1.5% lower for

animals that stayed overnight) for the lambs reared indoors ($p<0.001$; Table 1). These results indicate that animals react differently on transportation and lairage. One possible explanation is once again the age of the lambs, animals reared indoors are usually younger when sent to slaughter compared to animals reared on pasture, and the younger lambs might be more affected of transportation and lairage. Additional, irrespective rearing system but not significant for the pasture group, a lower fat score were seen in lambs staying overnight which could be due to a higher response to stress. The differences in response to lairage could also be due to genetic effects, i.e. an effect of breed. In Australia it has been seen that both pure bred Merino sheep, a breed bred for high fleece quality, and Merino-crosses are more susceptible to stress than other breeds bred for high growth rate and carcass quality (MLA, 2012). That might be the case with the breeds Gotland and Finull as well. Unfortunately the information of the breed of the lambs included in this study was insufficient to be able to draw such conclusions.

Further research is needed to either strengthen or exclude the possibility that lairage have an effect on carcass weight and dressing percentage. Future studies should be conducted under more controlled circumstances to be able to see whether the response to lairage differ between rearing systems, breeds, age of the lambs etc. It would also be of importance to investigate which on-farm factors that are of importance for a successful production in different rearing systems. Further it is of high relevance to study the environment on the abattoirs and what can be done there to minimise stress.

Unfortunately, no information about whether lairage effect the skin quality or not could be obtained in this study. The question was asked to a few abattoirs but they could not say. In order to investigate this, the skins need to be identified and the controlled against which lamb did stay overnight and which was slaughtered on the day of arrival. One of the companies preparing skins stated that about 5% of all skins were damaged in one way or another.

Economy

Lairage led to 1% higher dressing for lambs reared on pasture and 1.5% lower dressing for lambs reared indoors. During 2015, 255.501 sheep and lambs were slaughtered in Sweden. If 60% of those are in lairage overnight at the abattoir, it results in a total of 153.300 individuals. The average live weight in this study was about 42.5 kg, an average loss of 1.5% in carcass weight is then equal to 0.64 kg. That gives us a total loss just over 98.000 kg worth about 4 million SEK (based on a price of 41.50 SEK/kg [Scan 2016-06-28]).

Conclusions

Lairage did effect the carcass weight and the dressing percentage. The results are, however, contradictory depending on whether lambs are reared on pasture or indoors. More research is needed to reveal if lairage cause too much stress or if it allows the lambs to rest.

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