The welfare of sheep sold for live export

Discusses aspects of welfare during both land and sea transport, and the implications of recently discovered feed additives: flaxseed and quercetin.

By Lizzy Hewitt

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Introduction

Animals sold for live export are transported by both road and sea, journeys that can have a detrimental effect on their welfare (Cockram, 2007). While road transport is considered fairly commonplace, the comparatively recent boom in overseas demand for live meat has seen a push for animal-welfare standards to be improved (Phillips & Santurtun, 2013). Potential stressors, such as variations in microclimatic conditions, can be measured through biochemical changes and observations of animal behaviour (Dalmau, *et al*., 2013; Pines & Phillips, 2013) and must be limited. Recent studies indicate that these stressors can be moderated to a certain extent by use of dietary supplements, such as flaxseed (Benavides, *et al*., 2013).

Discussion

Stress is defined by Dalmau *et al*. (2013) as any environmental effect that can overwhelm an animal's control systems, thereby causing a reduction in fitness and thus welfare. A study by Dalmau *et al*. (2013) measured differences in blood biochemistry, salivary and faecal cortisol concentrations, and meat quality between a 1- or 24-hour road transit period in sheep (n=40). The only biochemical result affected by extended transport was blood urea nitrogen concentration (BUN), which was higher in the 24-hour group. This may have been due to increased muscular activity, increased protein catabolism due to prolonged food deprivation, or dehydration. Providing animals with appropriate food and water may increase the accuracy of future studies. The study also showed a significant increase in faecal cortisol concentration for both groups ($P<0.05$), and a trending increase in salivary cortisol concentrations. This increase was greater in the 24-hour group, suggesting that stress was cumulative and warrants monitoring.

In contrast, Pines & Phillips (2013) measured the macroscopic changes in a group of sheep (n=20) travelling by boat for a period of 10 days. Behavioural changes were measured in response to variations in ammonia concentrations, temperature and airflow. Pens with recorded high concentrations of ammonia and low airflow caused a decrease in feeding and rumination, increased standing time, increased height of head carriage and an increased prevalence of conjunctivitis ($P<0.05$) when compared to pens with lower concentrations of ammonia and increased airflow. Pulmonary irritation was also indicated at higher ammonia concentrations, through both coughing and sneezing. To increase the accuracy of future studies, biochemical measures, as assessed by Dalmau *et al*. (2013), should be undertaken in conjunction with behavioural studies. This will specifically link the two, providing a greater understanding of the stress response. Further, a specific measure of conjunctivitis (i.e., tear production and extent of conjunctival inflammation) (Hosie & Greig, 1995) should be deployed to ensure that eye closure is not due to an outlying factor and to provide a means of rating the impact on welfare.

Regardless of the mode of transport, duration was shown to play a role in the stress response of sheep. Serum cortisol concentrations indicated a stress response (Siegel & Gross, 2007) during a 4-hour travel period (Benavides *et al*., 2013), whereas over both 1 and 24 hours, no change was noted (Dalmau *et al*., 2013). This may have been due to differing study conditions, such as handling procedures (increased handling was shown to increase cortisol concentrations (Yardimci *et al*., 2012), age of the sheep, quality of the transport vehicle, or climate at the final destination. Another possibility suggested by both Dalmau *et al*. (2013) and Cockram (2007) is that, over a longer journey and after initially increasing, serum cortisol concentrations return to a more basal level, or sheep simply adapt to their surroundings. Pines & Phillips (2013) reiterated adaptation in their study, in that sheep became rhythmical in feeding and resting patterns toward the second half of the 10-day voyage.

Recent efforts have been made to increase welfare through the development of feed supplements that are capable of minimising transport-related stress. A study by Benavides *et al*. (2013) contrasted the effects of sheep diets containing flaxseed, quercetin, and a combination of both when compared to a control group (n=36). Results showed flaxseed to reduce white blood cell count and creatinine phosphokinase (CPK) concentrations indicating a lower level of inflammation and tissue damage,

respectively. Further, each test group was immunised with albumin (Ova) and several weeks later had blood tests for anti-Ova IgG. The sheep fed on flaxseed showed significantly less antibody production, demonstrating its immune-modulating properties. This is due to the presence of n-3 fatty acids and high levels of antioxidants, which are thought to minimise the production of pro-inflammatory cytokines (Benavides *et al*., 2013). Such a substance may prove useful in conditions shown to promote conjunctivitis (Pines & Phillips, 2013) through minimising inflammatory discomfort. Additional research should focus on further understanding these properties as they could deliver significant benefits to animal welfare.

Further, the pulmonary inflammatory response present in sheep travelling in high-ammonia conditions (Pines & Phillips, 2013; Phillips & Santurtun, 2013) could theoretically be reduced by adding flaxseed to the diet. This would increase welfare by decreasing the stress associated with pulmonary irritation (such as sneezing) (Phillips & Santurtun, 2013). Additionally, flaxseed has been implicated in the reduction of blood tissue damage indicators, such as CPK (Benevides *et al*., 2013), and thus carcass quality (Dalmau *et al*., 2013). While the study by Dalmau *et al*. (2013) showed no increase in CPK, there are other indicators available for measure (e.g., BUN) and these should be investigated further for their potential welfare and economic gains.

Conclusion

Due to recent research efforts, the distress of sheep during both road and sea transport is now quantifiable in terms of both biochemical analysis and behaviour characteristics (Dalmau *et al*., 2013; Pines & Phillips, 2013). As a result, welfare standards can be improved by targeting stress-inducing aspects of travel, such as ammonia concentrations, airflow, and handling procedures (Various/Cockram, 2007). They can be further improved by increasing the animals' ability to cope with stress, by adding flaxseed and quercetin to their feed (Benavides *et al*., 2013). Such advances impact not only on animal welfare, but have direct implications for the economic value of stock through delivering higher carcass quality (Dalmau *et al*., 2013).

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