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Estimating the impact on food and edible materials of changing scrapie control measures: The scrapie control model

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ABSTRACT

Multiple controls established during the bovine spongiform encephalopathy (BSE) epidemic were not solely applied to BSE in cattle, but were implemented for scrapie in sheep and goats due to concerns over the occurrence of BSE in sheep. In the absence of BSE in sheep being observed, control measures for prion diseases are now being evaluated to ensure they remain proportionate to risk. This risk assessment, aims to estimate, by use of stochastic simulation, the impact of reducing controls for Specified Risk Materials (SRM) from sheep at abattoir. Three scenarios have been included: 1) current list of SRM; 2) brain and spinal cord of adult sheep; and 3) the brain of adult sheep.

Results indicate the total amount of infectivity passing through British abattoirs is highest for atypical scrapie with nearly 3,500,000 Ovine Oral (OO) ID_{50} per year. The majority of this infectivity enters Category 1 waste for incineration, with only 13,000 OO ID_{50} per year within edible products. Under Scenario 2, an additional 4000 OO ID_{50} per year would be classified as edible products from the lifting of restrictions on the distal ileum of adult sheep. However, if SRM removal was limited to brain, an additional 110,000 OO ID_{50} per year would be permitted into edible products with the lifting of restrictions on the spinal cord of adult sheep.

For classical scrapie, there is a mean estimate of infectivity of 30,000 OO ID_{50} per year at abattoir. This is lower than for atypical scrapie due to the lower occurrence of this disease in Great Britain. However, more infectivity is destined to reach the food chain as the disease is peripherally distributed in the carcase. The highest contributor to the total amount of infectivity consumed per year is the intestines (duodenum and jejunum). If SRM removal is limited to the brain and spinal cord of sheep over 12 months of age, there is an approximate mean increase from 19,000 to 21,000 OO ID_{50} per year diverted to edible products. If the SRM list is restricted to brain only, this increases to over 23,000 OO ID_{50} per year.

For the potential of sheep-BSE, there is a very low estimate of 29 OO ID_{50} per year in total from carcases entering abattoir, due to the potential very rare occurrence of this disease. Given changes in SRM regulations there is a change of an additional 4 OO ID_{50} per year being diverted to edible products.

1. Introduction

In view of the steady decline in observed casesin European countries for Bovine Spongiform Encephalopathy (BSE) in cattle, European wide regulations have been amended to ensure that controls at the animal level and food chain are proportionate to the current level of risk. Such discussions are not limited to control measures focused on the prion protein in cattle, but also classical scrapie and atypical scrapie in sheep and goats. This is due to the escalation of controls on prions occurring in small ruminants in the wake of the BSE in cattle epidemic in the 1990s. Concern was high that detected scrapie in sheep may have been hiding the occurrence of BSE in small-ruminants which was justified subsequently after confirmation of naturally occurring BSE in goats (Eloit et al., 2005; Spiropoulos et al., 2011). In view of this concern, specified risk materials (SRM) (Table 1) have been removed from small ruminant carcases at abattoir and categorised as the highest risk tissues defined as Category 1 materials. Such waste is incinerated to reduce any risk associated with use in the food chain or in the production of other protein materials such as Category 3 materials, which may be used in products such as pet food and soil improvers.

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Table 1
Designated specified risk material which are removed from sheep and goats by age in accordance with point 1 of Annex V of EC Regulation 999/2001 (as amended). Meat Industry Guide 2017.

Age	Specified Risk material
All	Spleen and ileum
Over 12 months (or have a permanent incisor erupted)	Skull including the brains and eyes, tonsils, spinal cord

For classical scrapie, both active and passive surveillance are vital in achieving the goal of eradicating the disease. Active surveillance began in January 2002 as a result of Regulation (EC) No. 999/2001 (EC, 2001) and the recommendation of the Spongiform Encephalopathy Advisory Committee (SEAC) to estimate the prevalence of sheep and goat scrapie in the British flocks. The programme includes surveys on the slaughtered population and the fallen stock on farm. In addition to this, passive surveillance is also conducted in parallel where suspect cases are reported and tested.

The European Union (EU) requirement for testing sheep over 18 months of age for the United Kingdom (UK) is 20,000 in total with a baseline of 50% from sheep slaughtered for human consumption at abattoirs and 50% from fallen stock. However, the UK takes advantage of a derogation of the EU TSE Regulation to replace up to 50% of their requirement for sheep tested for human consumption with the same number of sheep fallen stock. On this basis, the UK tests at least 5000 sheep over 18 months of age slaughtered for human consumption and the remaining 15,000 samples obtained from the fallen stock survey over 18 months to meet the overall requirement of 20,000. The EU requirement for testing fallen goats over 18 months of age is set at 500 for the UK. Table 2 displays the results of UK surveillance from 2005 to 2016.

In the last 5 years new outbreaks of classical scrapie have not been confirmed in GB. The surveillance has been further enhanced by the introduction of the Compulsory Scrapie Flock Scheme (CSFS), which aims to closely monitor scrapie-affected holdings through surveillance of fallen stock and slaughtered animals. The holdings where scrapie has been confirmed are placed under movement restrictions, which lasts for two years following the detection of the last case of classical scrapie and follows the full implementation of the relevant controls, as appropriate, during which animals aged over 18 months of age that die (fallen stock) or are killed for human consumption must be TSE tested. Should this monitoring option fail to be successful, the holding will be reassessed to where other options such as killing and destruction of all sheep or goats in the holding or compulsory culling of all sheep genetically susceptible to classical scrapie will be implemented as laid down in Annex VII of the EU TSE regulations. An additional control for classical scrapie was called "The National Scrapie Plan" or NSP, introduced in July 2001 and ending in 2012, which had the effect of reducing the most susceptible genotypes within the national sheep population.

Table 2
UK surveillance for classical and atypical scrapie from 2005 to 2016.

	Abattoir			Fallen stock		
Year	Number Tested	Classical	Atypical	Number Tested	Classical	Atypical
2005	11,864	17	16	9,683	29	6
2006	48,971	8	36	21,225	38	13
2007	26,469	6	19	15,214	19	15
2008	10,761	2	5	11,793	6	6
2009	11,255	3	16	10,819	2	9
2010	8,423	1	13	10,460	0	6
2011	7,423	2	11	12,725	3	12
2012	7,009	0	11	13,452	2	18
2013	7,254	0	3	12,842	3	13
2014	7,396	0	4	12,866	0	7
2015	5,488	0	9	14,767	2	6
2016	6,915	0	4	13,534	0	9

Atypical scrapie was first identified in Norway in 2003. Previous studies have not found any risk factors associated with an infectious origin suggesting that atypical scrapie in sheep is a spontaneous disease (Fediaevsky et al., 2009). However, oral transmission of atypical scrapie has been experimentally demonstrated (Simmons et al., 2011) suggesting this prion disease could be transmitted by feed and environmental pathways.

BSE in small ruminants had been experimentally produced by the oral route (Foster et al., 1993) and it was known that BSE-infected bovine material in meat and bone meal feed was fed to small ruminants as protein supplements in the 1980s and 1990s. Therefore it was not a significant surprise when two naturally occurring cases of classical BSE were found in goats, one in France, and one in Scotland. The Scottish case of BSE in a goat was originally tested and confirmed as a scrapie case in 1990. Following the confirmation of BSE in a goat in France in 2002 (Eloit et al., 2005), the UK carried out discriminatory immunohistochemistry on the scrapie positive goat samples. This case was found to be positive for BSE in 2005 (Jeffrey et al., 2006). Tissue samples from this case were further characterised by mouse bioassay and the outcomes reported in 2009 as BSE (Spiropoulos et al., 2011).

With only two naturally occurring cases, it has been difficult to estimate an approximate prevalence of the occurrence of BSE in small ruminants. Kao et al. (2002) and Ferguson et al. (2002) used data from a small sample of brains (156 and 180, respectively) that were being studied by bioassay to estimate that approximately 2% of scrapie cases could be masking sheep-BSE at the 95% confidence limit. The 95% confidence limit is often quoted, rather than the mean, as selection bias and other complexities in the data make this the most appropriate estimate of the data available (Gravenor et al., 2003). Other risk assessments have utilized different maximum and minimum proportions of scrapie that are assumed to be sheep-BSE cases. Ferguson et al. (2002) utilized 0.5% to 2%, while Det Norske Veritas (2002) used much larger intervals by considering arbitrary scenarios where the value ranged from a minimum of 0.01% to a maximum of 10%, with a "medium" value of 0.1%. In 2004, the Veterinary Laboratories Agency (VLA) reported to the Food Standards Agency (FSA) on the outcome of a 2-year project to screen brains of scrapie suspects using the method of Stack et al. (2002). Gubbins (2004) has used these data to estimate the maximum proportion of sheep TSE cases that could be BSE under different assumptions about the sample size. Based on the assumption that the cases tested represent a random sample, the upper 95% confidence interval is that 0.14% of cases could be BSE positive. Finally in 2007, after the discovery of the two natural cases of small ruminant BSE, the European Food Safety Authority (EFSA) published an Opinion which calculated that, depending on the statistical model and the sub-set of input surveillance data, there was 95% confidence that in the UK there were less than 2–4 sheep-BSE cases per 10,000 healthy-slaughter sheep (EFSA, 2007).

The BSE control model was a risk assessment developed in the UK to monitor the estimated amount of BSE infectivity from cattle entering the food chain each year based on current or theoretical surveillance and SRM control scenarios (Adkin et al., 2010). This work was previously developed under the TSE research portfolio in 2004, and has been subsequently updated and maintained under the surveillance contract, with annual results for GB provided to assist policy makers at Defra and FSA when considering the UK response to European proposals to change BSE legislation.

Over the last few years a number of scrapie related projects have yielded data on the estimated occurrence and titres of scrapie infectivity in different tissue types for classical and atypical scrapie. Additional statistical work has used these data to parameterise certain variables of use in risk assessment. Given the interest at a European level for the deregulation of scrapie SRM controls in line with BSE