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Alternative risk management for C. bovis in cattle post mortem

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Executive Summary

Humans are the primary host of the tapeworm *Taenia saginata*, and the tapeworm eggs are passed in human faeces. Viable eggs can be ingested by cattle and form cysts in their muscles. While cysts become non-viable over time, the life cycle is completed if viable cysts are ingested by humans in raw or undercooked beef, as thorough cooking destroys these cysts.

Under the Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption (AS4696:2007), inspection of cattle at slaughter requires examination for the presence of *C. bovis* lesions, including incisions of the heart and masseters. However, it has long been recognised that post-mortem meat inspection (PMI) of predilection sites (including heart and masseters) lacks sensitivity, especially in light infections. Such light infections can occur even in industrialised countries, including Australia, where *T. saginata* is not endemic in the human population and cattle are generally not grazed on pastures that have been irrigated by sewage.

For this reason a Quantitative Risk Assessment (QRA) model was developed to quantify the risk of human *T. saginata* infection from consumption of Australian beef, and investigate the effect of reducing current PMI protocols by removing the need to incising the masseters, or removing all incisions, for low risk cattle. This model followed that developed by van der Logt et al. (1997), though data on *C. bovis* published since then was incorporated and the model was adapted to the Australian context.

The results of the QRA indicate that the risk of human *T. saginata* infection from consumption of Australian beef is very low – a median 1.78 (95% Credibility Interval: 0.13-13.37) and 0.77 (0.06-4.78) cases per 1 billion 300g serves consumed in the domestic and top 5 export markets (USA, Japan, Korea, China and Canada), or the equivalently 2.68 (0.19-20.13) and 2.71 (0.21-16.87) illness per year, respectively. Moving to reduced PMI, which only includes incisions of the heart, was estimated to result in a negligible increase in risk – 1.83 (0.12-14.07) and 0.81 (0.06-5.11) in the domestic and export markets, respectively. This is equivalent to one additional infection every 12.5 and 6.7 years in the domestic and export markets. Further reduction in PMI requirements, *i.e.* visual only PMI, were estimated to result in a small increase in risk to 2.14 (0.14-16.33) and 0.94 (0.07-5.83) per billion servings, or 3.22 (0.20-24.57) and 3.32 (0.24-20.57) illness per year – a median increase of about one additional cases per 1.8 and 1.6 years in domestic and export markets, respectively, compared with current PMI.

Moving to visual only inspection could be supported by better national data capture of *C. bovis* through the National Livestock Identification System or through Animal Health Australia's endemic disease surveillance program. This way, PMI for cattle from high risk farms – using sewage irrigation of pasture or where *C. bovis* had been detected in the past – would revert to current intensified inspection requirements stipulated in the Australian Standard.

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1 Background

Humans are the primary host of the tapeworm *Taenia saginata*, and the tapeworm eggs are passed in human faeces. Viable eggs can be ingested by cattle and form cysts in their muscles. Cysts become non-viable 18 months to two years after cattle are first exposed. The life cycle is completed if viable cysts are ingested by humans.

Under the Australian Standard for the Production and Transportation of Meat and Meat Products for Human Consumption (AS 4696:2007, the Australian Standard), inspection of cattle at slaughter requires examination of heads, carcases and viscera for the presence of lesions caused by *C. bovis*. Sites inspected routinely are the heart, masticatory muscles and other exposed muscle surfaces. In lightly infected animals, the Australian Standard allows for trimming of the detected cysts, plus freezing of the carcase for an extended period to render remaining cysts non-viable. Cooking also easily destroys these cysts.

At worst, the risk to consumers from intestinal infestation with the tapeworm *T. saginata* can be described as “Moderate – not usually life threatening; no sequelae; normally short duration; symptoms are self-limiting; can be severe discomfort”.

A prevalence survey of 495,000 Australian cattle found only 23 animals with suspicious lesions. Laboratory testing identified five as the degenerated hydatid cysts, five were neoplasia, two were Actinomycosis/bacillosis with one “other”. The remaining 10 did not have sufficient DNA to provide any diagnosis.

It is widely acknowledged that the organoleptic *C. bovis* inspection procedures (incising and observing cheeks and hearts) lacks sensitivity, only detecting the parasite in about 15 to 33% of infected animals. This results in failure to detect the disease in many animals, particularly those with only light infections. It is also recognised that of the inspection sites listed above, the heart is the most reliable site in which to find lesions.

The EU allows alternate approaches to the management of *C. bovis* in their latest Directive and the US Food Safety and Inspection Service have already approved an alternate approach in New Zealand. This approach was based on a Quantitative Risk Assessment which was undertaken to assess the increase in risk of *T. saginata* infection under a reduced inspection model.

Similar to NZ, the prevalence of *C. bovis* in Australian cattle is estimated to be low, i.e. 1/500,000 (Pearse et al, 2010). Using these data, information about efficacy of post-mortem inspection methods and Expert Opinion to estimate data gaps and uncertainties, estimate of risk, and changes as a result of alternate inspection methods, can be modelled. This approach will provide quantitative risk data which can be used to underpin cessation of specific post-mortem inspection procedures for *C. bovis* in Australia and negotiation of acceptance by customers.

2 Project Objectives

Develop a quantitative risk assessment model to estimate the risk of *T. saginata* infection from

1. current inspection methods for detection of *C. bovis* in cattle.
2. reduced inspection methods for detection of *C. bovis* in cattle.

3 Methodology

A quantitative risk assessment model and scientific documentation has been developed using a reproducible research framework as described by Schulte et al. (2012). Using this approach, the computer code for the quantitative risk assessment (QRA) model, which was implemented using the open-source statistical software R v3.3.2 (R Core Team 2016), is interweaved with the scientific justification and documentation of the model. This way, the approach is both repeatable and transparent.

The details of the QRA model are based on the work by van der Logt et al. (1997). While the main parts of the model are similar, a literature review was undertaken to ensure that the assumptions and data used by van der Logt et al. (1997) are still appropriate, update them where they are not, and modify them to be relevant to Australia rather than New Zealand.

The details of the model, results and discussion are provided in the model report, which is provided in Appendix 1.

4 Conclusions/Recommendations

As described in the model report (attached), a number of options for risk management consideration arise from the outputs of this quantitative risk assessment. These include:

1. Aadopting a revised inspection procedure for *C. bovis* by deleting the need to incise masticatory muscles (internal and external) from Table 3 in AS 4696 due to the negligible effect on risk of eliminating this procedure.
2. Retaining current inspection procedures for all stock from properties subject to sewage irrigation and other properties previously identified as *C. bovis* positive.
3. Establishing a national register of *C. bovis* cases in the NLIS database to monitor trends and inform extension where needed.
4. Use the national data, developed as part of Recommendation 3, to reassess the effect of moving to visual only inspection, if not done now on the basis of this QRA, i.e. eventually delete the need to palpate and incise the heart for cattle from Table 3 in the Australian Standard.
5. Developing equivalence submissions with trading partners to apply domestic standards to exported product.

It is recommended that the model report and these options are submitted to the Australian Meat Regulators Group for consideration. This should be done as part of the overall approach as part of MLA Project V.RBP.0020 “Review of the Post-mortem Inspection and Disposition Schedules of the Australian Standard 4696” where results of studies have been requested by AMRG as they become available.

In addition, it is also recommended that draft journal manuscript (Appendix 2) be submitted to the journal Food Control, so the work can be internationally reviewed and the scientific basis for risk management proposals can be transparent.

5 Bibliography

Pearse BHG, Traub RJ, Davis A, Cobbold R, Vanderlinde PB (2010) Prevalence of Cysticercus bovis in Australian cattle. *Australian Veterinary Journal* **88**, 260–262. doi:10.1111/j.1751-0813.2010.00593.x.

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van der Logt PB, Hathaway SC, Vose DJ (1997) Risk Assessment Model for Human Infection With the Cestode Taenia saginata. *Journal of Food Protection* **60**, 1110–1119.

6 Appendix 1 (attached)

See attached model report.

7 Appendix 2 (attached)

See attached draft manuscript, formatted for submission to the journal Food Control.