PhD defence Famke Jansen

Modelling Taenia saginata epidemiology and control in Belgium

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Dit is de omschrijving

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Summary:

Bovine cysticercosis (BCC), infection with the larval stage present in cattle muscle, is currently diagnosed solely by official meat inspection (MI) based on macroscopic detection of viable cysticerci or typical lesions of degenerated larvae. MI has a known low sensitivity (<16%), leading to a large proportion of infected cattle carcasses entering the human food chain and posing a risk to public health. Prevalence in Belgium based on MI results is estimated at 0.23%. Due to the low sensitivity of MI, alternative techniques to detect BCC should be considered. The objectives of this thesis are to determine the true prevalence of BCC and the economic impact related to *T. saginata* in Belgium, defining the test characteristics of currently used tools and determining the effect of an improved detection technique for BCC at slaughter on the prevalence of BCC and taeniosis and on the economic impact.

Three Belgian slaughterhouses were visited during ten months in consecutive years. In total, 101 carcasses positive on MI and 614 carcasses negative on MI were sampled. Collected samples consisted of blood and the predilection sites (tongue, heart, masseter muscles, diaphragm and oesophagus). Several detection tests were performed on the samples: MI, MI with additional incisions in the heart, specific antibody detection against excretory/secretory (ES) antigens in the Ab-ELISA and circulating antigens in the B158/B60 Ag-ELISA.

During the study, mostly carcasses with (very) light infections were detected containing predominantly degenerated or calcified cysticerci and only few viable cysticerci. Dissection of the predilection sites detected 144 (23%) additional infections in the 614 MI-negative carcasses. When performing first the dissection of the predilection sites, followed by the Ag-ELISA and the Ab-ELISA, an additional 36% of MI-negative carcasses were found positive for BCC, resulting in a much higher prevalence than the above mentioned 0.23%. The repeatability and border of the plate effect were tested for the B158/B60 Ag-ELISA, as interpretation of test results requires a good knowledge of the test characteristics.

A Bayesian model was developed to estimate values for the prevalence and diagnostic test characteristics of BCC by combining results of enhanced MI, dissection PS, B158/B60 Ag-ELISA and ES Ab-ELISA on samples of 612 MI-negative bovine carcasses. This Bayesian approach allows for the combination of prior expert opinion with experimental data to estimate the true prevalence of BCC in the absence of a gold standard test. Prior expert information about specificity and sensitivity resulted in an optimal model. The estimated BCC prevalence was 33.9% (95% CI: 27.7% - 44.4%), while apparent prevalence based on meat inspection is only 0.23%. The test performances were estimated as follows (sensitivity (Se) - specificity (Sp)): enhanced meat inspection (Se 2.87% - Sp 100%), dissection of predilection sites (Se 69.8% - Sp 100%), Ag-ELISA (Se 26.9% - Sp 99.4%), Ab-ELISA (Se 13.8% - Sp 92.9%).

A first complete quantification of the yearly economic impact of BCC in Belgium was made, for the reference period 2012-2016. The biggest proportion of

the total economic losses per year were borne by the cattle owners with an average economic cost of 3,579,335 euro per year: 3,124,940 euro/year due to the insurance for BCC, 453,025 euro/year due to value losses of beef (freezing processes of uninsured animals (65%)) and 1,370 euro/year due to destruction costs of carcasses with generalised infections. The slaughterhouses suffered a lower economic impact of 210,585 euro/year. They were responsible for the inspection costs related to meat inspection in general, administration, processing and deboning of infected carcasses (597,483 euro/year), the value losses and destruction costs of carcasses insured by the slaughterhouses (5% of slaughtered animals) (34,923 euro/year) and had an income of insurance fees (421,746 euro/year). Thirty percent of all slaughtered animals were officially insured against BCC and the insurance company generated an income of 2,535,167 euro per year. The costs related to taeniosis amounted to a maximum of 795,858 euro per year (depending on the proportion of patients consulting a physician).

A mathematical model was built in Rstudio to determine the current prevalence of BCC using official MI and results of the dissection of the PS and the B158/B60 Ag-ELISA on serum of the 614 MI-negative carcasses. Additionally, the impact of the introduction of the B158/B60 Ag-ELISA at slaughter on the prevalence of BCC and taeniosis and on the economic impact related to *T. saginata* was estimated. The model estimated the current prevalence of BCC to be 42.5% and the sensitivity of the MI for viable and degenerated cysticerci at only 0.54%. The number of human taeniosis cases is estimated at 11,000 by using the sale numbers of niclosamide in Belgium. Implementation of the Ag-ELISA at slaughter would greatly reduce the prevalence of BCC to 0.6% and the number of taeniosis cases to 89 after ten years. Unfortunately, the accompanying resulting increase in costs for the animal owners, slaughterhouses and the insurance company, would be extremely high in the first years.

The work in this thesis estimated the prevalence of BCC in Belgium at 30 - 40%, one hundred times higher than reported by the Federal Agency for the Safety of the Food Chain. Implementation of the B158/B60 Ag-ELISA as a detection mechanism at slaughter would induce a high decrease in prevalence of BCC and taeniosis, but it comes with a very high, unacceptable cost during the first years. As human tapeworm carriers are essential for maintaining transmission, the human health sector and the environment need to be included in control programs to reduce the risk of *T. saginata*.