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SHORT COMMUNICATIONS

No evidence of *Trichinella* spp. in domestic pig carcasses at a selected abattoir in southern Botswana

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Abstract
Trichinellosis is a worldwide zoonosis with genotypes affecting different domestic and wild animals and is widely distributed throughout the world. Species and genotypes of this genus affecting different animals have been identified. Despite its occurrence in Sub-Saharan countries, the presence of trichinellosis in Botswana is yet to be confirmed. The objective of this study was to determine the prevalence of *Trichinella* infection in domestic pigs slaughtered at an abattoir in Gaborone, Botswana. Of the 111 pig carcasses selected, 5 g of crus of the diaphragm was collected from each carcass, trimmed of all fat and fascia and then cut into 1- to 2-g samples. The muscle samples were pooled into 100-g muscle sample and then processed by the OIE prescribed digestion method. A stereomicroscope was used to examine each grid of the Petri dish for the presence of *Trichinella* larvae. No *Trichinella* larvae were found in any digested muscle samples. Future studies should target a wider pig population and other host animals.

Keywords *Trichinella* · Trichinellosis · Pigs · Botswana

Introduction

Livestock production, contributing only 2.4% of GDP and constituting 80% of agricultural production, is a major source of income for smallholder farmers in Botswana (US Commercial Service 2017, https://www.export.gov/article?id=Botswana-Agricultural-Sectors accessed on July 6, 2018). Pig production is among the Government's efforts to diversify from the predominant beef industry (Montsho and Moreki 2012).

The Botswana's market share of pork is estimated at 0.06% of Africa's output and 0.005% of the world's total output (Montsho and Moreki 2012). Pig production (mostly small-scale semi-intensive system) is concentrated in the cities and big villages to suit market and demand for pig products (Moreki and Mphinyane 2011). The challenges faced by the pig industry include unorganised markets, inadequate slaughter facilities, quality, price and supply of feeds, inappropriate management techniques, inadequate breeding stock and diseases (Galeboe et al. 2009).

Trichinellosis is a worldwide food-borne zoonotic disease, caused by up to 12 identified species of *Trichinella* (Gottstein et al. 2009; Murrell and Pozio 2011). Of the 12 known species, only *Trichinella britovi*, *T. nelsoni*, *T. zimbabwensis* and *Trichinella* T8 (limited to Southern Africa) have been reported in Sub-Saharan Africa (Marucci et al. 2009; Mukaratirwa et al. 2013). In southern and eastern Africa, both *T. nelsoni* (Marucci et al. 2009) and *T. zimbabwensis* (Pozio et al. 2007; La Grange et al. 2009, 2013) have been isolated.

Trichenella spp. maintain a sylvatic and a synanthropic cycle affecting mostly wild carnivores (lion and spotted hyena) and rodents, respectively (Mukaratirwa et al. 2013). *T. zimbabwensis* has mainly been restricted to the Nile crocodile (Pozio et al. 2007; La Grange et al. 2009, 2013). Despite the evidence of experimental infection of *T. zimbabwensis* in different mammals and reptiles, its natural occurrence in the domestic pig has not been reported (Hurnikova et al. 2004; Pozio et al. 2007; Mukaratirwa et al. 2008). In Zimbabwe (Mukaratirwa et al. 2013) and Tanzania (Magwisha et al. 2017), there was no evidence of *Trichinella* spp. infection

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within the domestic pig population. Although the seroprevalence of *Trichinella* spp. was 2.1% in a recent study in Uganda, attempts to isolate *Trichinella* larvae from muscles using the artificial digestion method were unsuccessful (Roesel et al. 2016).

Human trichinellosis has been reported in different parts of the world and less so in Sub-Saharan Africa (Mukaratirwa et al. 2013; Calcagno et al. 2014; Jeong et al. 2015). Outbreaks of human trichinellosis are mainly associated with the consumption of bushpigs (Dupouy-Camet et al. 2009). In the Republic of Guinea, the consumption of well-cooked meat and religious laws that forbid the consumption of pork may contribute to the low prevalence of human trichinellosis (Pozio et al. 2005).

Botswana is not among the Sub-Saharan African countries reported by Mukaratirwa et al. (2013) where various *Trichinella* spp. have been identified. The objective of this project was to ascertain the presence and determine the prevalence of *Trichinella* spp. in domesticated pigs of Botswana.

Materials and methods

The study was conducted in Gaborone, Botswana. Botswana is landlocked, with a total area of 581,730 km^2, a human population of 2,024,904, a pig population of 11,104, an average altitude of 1000 m, temperatures well above 35 °C, summer rain (averaging 250 mm) between November and April, and dry winters (Thomson et al. 2005; Statistics Botswana 2014).

The study was conducted at a private abattoir registered for local pig slaughter in northern Gaborone with a daily throughput of about 50 pigs. At the time of conducting this research, there were only two abattoirs licenced for the slaughter of pigs in Botswana (one in Francistown and the other in Gaborone). Furthermore, the Francistown abattoir was closed by the Department of Veterinary Services, as part of a disease control protocol. Consequently, the Gaborone private abattoir was the only abattoir in operation during the study period. The selected abattoir is the only registered abattoir for pigs in southern Botswana. The facility licenced under the Livestock and Meat Industry Act Regulation Act of 2007 and Cold Store, Red Meat Abattoir; and section 9 of the Factory Act of 1973. Meat inspection at this abattoir is performed by the Department of Veterinary Services.

Gaborone region, with 3519 pigs, is a catchment area for this abattoir. In 2014, 377 pigs were slaughtered in Gaborone region (Statistics Botswana 2014). On each slaughter day, about 20% of the pigs were randomly selected by sampling every 10th slaughter pig to achieve a total of 111 pigs by the end of the study period. Five grams of the crus of the diaphragm was trimmed free of fat and fascia, cut into 1–2-g pieces, and then pooled into 100-g meat samples. The pooled meat samples were digested using a 50–100 ml solution of 37% hydrochloric acid (HCL)/water solution (0.55% *v*/*v* 37% HCL) and 10 g of pepsin (1: 10,000 NF/1:12,500 BP/2000 FIP) according to the modified OIE method of 2009 (Gómez-Laguna et al. 2011). A stereomicroscope was used to systematically examine each grid of the Petri dish for the presence of *Trichinella* larvae, at × 10–16 magnification. Any suspect larvae detected at systematic examination needed to be confirmed by morphological detailing at a higher (× 40) magnification. A test sensitivity of 90% (with a 95% confidence level) for samples containing three to five larvae per gramme was considered acceptable. The proportional occurrence of trichinellosis was determined in Microsoft Excel 2013. Since no larvae were detected in this study, only descriptive statistics were performed.

Results and discussion

No *Trichinella* spp. larvae were found in the muscle samples of the diaphragms of any of the 111 examined pig carcasses. In addition, *Trichinella* spp. in wildlife have never been investigated in Botswana. These findings are similar to those of a number of Sub-Saharan African reports (Mukaratirwa et al. 2013; Roesel et al. 2016; Magwisha et al. 2017). Reports from some parts of Southern Africa confirm the presence of *T. zimbabwensis* (Pozio et al. 2007; La Grange et al. 2009, 2013), *T. nelsoni* (Pozio et al. 2005; Marucci et al. 2009) and *Trichinella 8 (T8)* (Marucci et al. 2009). We suspect that *T. nelsoni* and *Trichinella* T8 genotype would have been the most probable *Trichinella* spp. in domestic pigs of Botswana since the former have been reported in neighbouring Namibia and South Africa (Mukaratirwa et al. 2013). The absence of *Trichinella* spp. in this study could be due to the low fecundity of the expected *Trichinella* spp. or due to a low undetectable parasite burden. Magwisha et al. (2017) recently reported the presence of *Trichinella* spp. antibodies but failed to isolate *Trichinella* larvae using the same digestion method. Therefore, results from this study do not completely rule out the absence of *Trichinella* spp. in pigs of Botswana. According to Calcagno et al. 2014, "the lack of the cases reported ought not to be taken as a proof of parasite absence". Future studies using larger sample sizes need to be done. The epidemiology of *Trichinella* spp. in the sylvatic cycle of Botswana also needs further investigation.

According to Randome et al. (2016), the prevalence of *Trichinella* spp. in Botswana pigs was 13%. However, the method they used to diagnose trichinellosis is not clearly described and is doubtful to say the least, as the digestion method and diaphragmatic crurae are not mentioned. Authors of this article observe that the methodology used by Randome et al. (2016) does not stand scrutiny as the report seems to imply that *T. spiralis* was recovered from gastrointestinal contents. Besides, in Sub-Saharan Africa, of the 12

species, only *T. britovi*, *T. nelsoni*, *T. zimbabwensis* and *Trichinella T8* genotype have been reported (Mukaratirwa et al. 2013). We therefore recommend that the earlier report by Randome et al. 2016 be set aside and maintain that there has not been evidence of trichinellosis in the domestic pig in southern Botswana taking cognisance of the fact that the lack of the cases reported ought not to be taken as a proof of parasite absence.

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Compliance with ethical standards

Ethical standards The manuscript does not contain clinical studies or patient data. This study was approved by the Department of Animal Science and Production Board, Botswana College of Agriculture.

Conflict of interest The authors declare that they have no conflict of interest.

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