



Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Asian Pacific Journal of Tropical Medicine

journal homepage: www.elsevier.com/locate/apjtm



Document heading doi:

A preliminary analysis of some epidemiological factors involved in porcine cysticercosis in Bafut and Santa subdivisions, North West Region of Cameroon

Nchang Allo Nicoline Ngwing¹, J Wabo Poné^{1*}, Mpoame Mbida¹, A Zoli Pagnah², H Njakoi³, CF Bilong Bilong⁴

¹Department of Animal Biology, Laboratory of Applied Biology and Ecology, Faculty of Science, University of Dschang, PO Box 067 Dschang, Cameroon

²Faculty of Agronomy and Agricultural Science, University of Dschang, PO Box 222 Dschang, Cameroon

³Heifer Project International (H.P.I), Bamenda, Cameroon

⁴Department of Animal Biology and Physiology, Laboratory of General Biology, Faculty of Science, University of Yaoundé 1, PO Box 812 Yaoundé, Cameroon

ARTICLE INFO

Article history:

Received 28 February 2012

Received in revised form 31 March 2012

Accepted 5 April 2012

Available online 20 October 2012

Keywords:

Cameroon

Cysticercosis

Pig

Prevalence

Seroprevalence

Taeniasis

ABSTRACT

Objective: To examine the magnitude and some risk factors of porcine cysticercosis in Bafut and Santa, two sub-divisions noted for pig farming in the North West Region of Cameroon. **Methods:** A total of 499 pigs in 300 households were examined by tongue inspection and serologically by Ag-ELISA. Information was sought on the age and sex of the animals, prevailing husbandry systems, types of feed, the state of each pen and the state of toilets. Furthermore, a questionnaire was administered to the farmers to determine their awareness on taeniasis/cysticercosis and related factors. **Results:** The prevalence of the disease was significantly higher in Santa (10.2%) than in Bafut (4.2%), although there was a higher level of awareness in both localities (62.3%). Age of pigs, traditional rearing systems (roaming, tethered, earth floor pen, raised floor pen), faecal disposal in the environment and poor sanitation significantly influenced the seroprevalence of porcine cysticercosis in both localities. Most farmers (79.7%) used a combination of concentrate, grass and kitchen waste to feed pigs. Financial loss from porcine cysticercosis was estimated at 346 900 CFA representing 2% of total income. **Conclusions:** Control measures advanced here include sensitization campaigns, periodic examination and treatment of infected pigs by veterinarians, improved husbandry systems, proper use of standard latrines regularly inspected by sanitary officers, and sound hygienic and sanitary practices.

1. Introduction

Taenia solium (*T. solium*) is a zoonotic helminth affecting primarily pigs and humans^[1,2]. The life cycle of *T. solium* involves a human as the sole natural definitive host carrying the adult parasite found in the small intestine resulting from consumption of insufficiently cooked pork meat infested with parasite larvae (*Cysticercus cellulosae*)^[3]. Pigs are the natural intermediate hosts of *T. solium* and get infected by ingesting eggs of the tapeworm in human faeces. Human

beings can also get infected with the eggs of the parasite and may develop severe neurological disorders if the larvae migrate to the brain, a condition called neurocysticercosis (NCC)^[4–6]. Human NCC is considered as the most dangerous form of *T. solium* infection in human and has been diagnosed worldwide^[7]. Most symptomatic cases of NCC will manifest with recurrent seizures or epilepsy^[8,9]. *T. solium* cysticercosis is an under-recognized economic and public health problem in many developing countries of Latin America, Asia and Africa^[10,11]. The human populations considered to be at highest risk of infection with this zoonotic helminth are people living in developing countries, particularly in Sub-saharan Africa, because they earn their livelihood wholly or partially through livestock rearing including pigs^[2,12,13]. *T. solium* cysticercosis causes

*Corresponding author: J Wabo Poné, Department of Animal Biology, Laboratory of Applied Biology and Ecology, Faculty of Science, University of Dschang, PO Box 067 Dschang, Cameroon.

Tel: 00 237 77881045/96255534

E-mail: nchangallonicole@yahoo.com

mental disturbances, intracranial hypertension, epilepsy in humans^[14]. Financial losses due to porcine cysticercosis have been reported by several studies elsewhere. Annual losses due to porcine cysticercosis have been estimated to 25 million Euros in 2002 in ten Western and Central African countries, US \$5.0 million in the Eastern Cape Province of South Africa in 2004^[15], US \$121 million for 0.2 billion kg of pork meat in China in 2002. In Mexico for example porcine cysticercosis is responsible for the loss of more than one half of the national investment in swine production and US \$17 million annually in hospitalisation and treatment cost for human neurocysticercosis. In Cameroon, human cysticercosis was first reported in 1985, in the West region and the cost for the treatment of the disease is estimated at US \$309 annually. That amount is largely beyond the reach of the majority of the rural household. The taeniasis/cysticercosis complex is associated with poor sanitation, hygiene, and methods of pig husbandry and lack of veterinary control. If the link between man and pig is broken, then the disease could be eradicated. Studies on taeniasis/cysticercosis have been carried out in the North, Far North, North West and Western Regions of Cameroon. The present study was conducted to assess the prevalence and to evaluate some associate risk factors of porcine and human cysticercosis in Santa and Bafut two, rural communities that earn their livelihood wholly or partially through livestock rearing and pig breeding.

2. Materials and methods

2.1 Study sites

The study was carried out in Santa and Bafut two sub-divisions in the North West Region of Cameroon. Santa is about 27 km from Bamenda the capital of the North West region. The temperature there varies from 10 °C to 26 °C, with an annual rainfall of 3 241 mm. Concerning Bafut subdivision, it is located 10 km from Bamenda. The temperature there varies between 14 °C and 29 °C and an annual rainfall of 2 000 mm. Just like in Santa, there are two seasons (rainy season and dry season) and the main activity is farming.

2.2. Data collection

2.2.1. Diagnostic technique

A total of 499 pigs (285 in Santa and 214 in Bafut) were submitted to tongue inspection and serological analysis.

Tongue inspection: Tongue inspection involved the

observation or palpation of the lower surface of the tongue to detect the presence of cysticercus nodules. The animals were restrained using a rope that passed through their mouths and between their teeth. This was to enable the mouths stay open for the inferior surface of the tongue to be inspected. During this manipulation, age, sex and weight of animals were registered.

Serological analysis (ELISA): About 5 mL of blood was collected from the jugular vein or from the ear vein of the animals using a vacutainer. All blood samples were allowed to clot in inclined sterile 10 mL test tubes within 3 h. The serum was separated after blood centrifugation and stored at - 20 °C until tested. Ag-ELISA technique was used as described by Dorny *et al*^[16].

2.2.2. Field survey data

A questionnaire was administered to the heads of the households to collect information concerning the awareness of pig cysticercosis, tapeworm in man, the rearing system, the feeding mode adopted by the farmers, the hygiene and sanitary conditions.

2.3. Statistical analysis

Descriptive statistics was used to present results obtained from the survey while the *Chi*-square was used to compare proportions at $P < 0.05$ ^[17].

3. Results

Out of 499 pigs examined for porcine cysticercosis, seroprevalence was significantly higher ($P < 0.05$) in Santa (10.2%) than in Bafut (4.2%). Tongue examination also revealed a higher prevalence in Santa (4.2%) than in Bafut (2.8%). Generally, prevalence of porcine cysticercosis was higher by serological analysis, compared to tongue examination (Table 1). The seroprevalence of porcine cysticercosis did not differ significantly between female and male pigs. The seroprevalence increased with age. The level of awareness of pig cysticercosis was higher in Santa (91.7%) than in Bafut (65.1%). The same tendency was observed in the awareness of the relationship between human taeniasis and pig cysticercosis, 91.7% and 35.1% in Santa and Bafut respectively. Concerning the rearing systems, the highest seroprevalence was observed in free roaming pigs (36.4%), followed by tethered pigs (29.3%), earth floor pen (10%) and raised floor pen (1.1%). All households considered in the study had toilets and made use of them. However, we noticed that some pens were used by children as toilets

Table 1

Prevalence of porcine cysticercosis by tongue inspection and seroprevalence (from Ag-ELISA test) of porcine cysticercosis in Bafut and Santa subdivisions.

Localities	Number of pigs examined	Number and percentage of infected pigs	
		Tongue inspection <i>n</i> (%)	Serology <i>n</i> (%)
Bafut	214	6 (2.8)	9 (4.2)
Santa	285	12 (4.2)	29 (10.2)
Total	499	18 (3.6)	38 (7.6)

(Figure 1). There was a significant association between the presence or absence of toilets and the seroprevalence. We observed that seroprevalence was significantly higher in communities where toilets were absent (50.0%) than where toilets were present (3.1%). Our results on mode of feeding showed that some pigs (79.7%) were fed on concentrate, grass and kitchen waste and others on grass and kitchen waste (11.6%). Given that out of 13 400 pigs estimated to be bred in Bafut and Santa subdivisions within the period of the study (20 months), financial loss from porcine cysticercosis in 18 infected pigs out of 499 pigs examined was estimated at 346 900 FCFA representing 2% of the total income including clandestine trading in infected pigs.



Figure 1. Ground floor pen used as latrine.

4. Discussion

The prevalence of porcine cysticercosis by improved tongue inspection techniques with the use of salt showed a lower prevalence (3.6%) than serological test (7.6%) in Bafut and Santa. This could be explained by the low sensitivity of the tongue examination method in lightly infected pigs. Similar findings have been reported[5,11,12]. Only massively infected animals can be diagnosed by this method[18]. The mean prevalence of tongue inspection ($3.6 \pm 1.2\%$) in both localities was similar to that reported in Batibo (4.4%) by Shey–Njila *et al*[19], and high to that obtained (2.9%) in Bas–Congo by Praet *et al*[20–23]. The mean prevalence obtained in this study was lower to 7.3% obtained by Ngowi *et al*[3] in Tanzania. Moreover, the prevalence of porcine cysticercosis evaluated by Ag–ELISA test was higher (7.6%) than by tongue inspection (3.60%). This finding confirms the fact that serological tests are much more sensitive[1,24,25]. The seroprevalence obtained in this study was closer to that reported in Uganda (8.5%) by Waiswa *et al*[12], lower to that reported (21.6%) by Kanobana *et al*[6] in a village community of Bas–Congo, Democratic Republic of Congo and high to the one reported (3.48%) in North Indian by Vitin Shukla *et al*[26]. The modified tongue technique used in this work can enabled buyers to easily identify cysticercosis nodules in pigs, so as to step down prices of infected pigs for consumption, or to check the quality of pigs they were to buy and rear. The seroprevalence of porcine cysticercosis was not significantly different in female and male pigs ($P>0.05$).

Concerning the influence of age on seroprevalence, we observed that this parameter increased with age. This could be explained by the fact that, in the course of higher search for food, adult pigs were highly exposed to contamination and also these pigs lived long enough for cysticerci to be noticed[27]. Even though 62.3% of respondent in both localities were aware of porcine cysticercosis and 44.9% aware of direct relationship between human taeniasis and porcine cysticercosis, the risk of transmission still exists because of food shortages resulting in infected life pigs and carcasses being sold cheaper in clandestine market for consumption. Also, pork consumed during traditional ceremonies is usually not adequately cooked. Out of the two husbandry systems, seroprevalence of porcine cysticercosis was significantly higher ($P<0.001$) in pigs kept traditionally (10.4%) than under improved husbandry system 2.3%. Pigs kept traditionally, were prone to pig cysticercosis because of direct access to human faeces, which constituted the main risk factor in both localities. The seroprevalence of porcine cysticercosis reduced to 10% with pigs reared on ground floor pens. This was due to the fact that some pens were still used as latrines. It is known that, the lacking of latrine constitutes an important factor associated with the transmission of cysticercosis[3]. We noticed on the field that, ground floor pens were used as toilets by children and sometimes by adults; this practice has been reported in the West and in the North West Regions of Cameroon[18]. The local authorities obliged the inhabitants to construct latrines but this measure did not oblige them to effectively use the latrines. Defecation in pig pens is not only as a means of faecal disposal in the area, but also a cheaper way of feeding pigs. Raised floor pen were the main rearing system in both localities, with the lowest seroprevalence rate of 1.1% of infected pigs. The lowest seroprevalence rate of 1.1% of porcine cysticercosis found in pigs reared in raised floor pens, in both husbandry systems were less likely to be infected. This was due to the fact that these pens were likely used as latrines or pigs were feed with human faeces or grass contaminated with *Taenia* eggs or infected pigs were bought ignorantly to be reared. This observation was similar to results reported from the North West Region of Cameroon[22]. Those farmers, who could strictly confined their pigs on raised floor pens, could meet up with the standard of (Heifer Project International) supported farmers who practiced the improved system. Mode of feeding is an important factor associated with transmission. Three feeding systems were practiced by the different households.

In conclusion prevalence of porcine cysticercosis is influenced by human behavioural factors such as faecal disposal systems, general hygiene, system of roaming in pigs and the feeding system. Socio–economic conditions of the population with respect to this zoonosis gave potential economic losses estimated at 346 000 FCFA (three hundred and forty six thousand, nine hundred) over a period of 20 months; respecting a great impact on the rural population living partly or entirely on pig rearing. Human and porcine cysticercosis can be eradicated on condition that the political and economic will permit the breakage of the life cycle of this parasite

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

The authors wish to thank the technical personnel of the taeniasis–cysticercosis Laboratory of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang. This work was financially supported by the Belgian Directorate General for Development Cooperation (DGDC, Brussels) within the framework agreement between DGDC and the Institute of Tropical Medicine, Antwerp. Our thanks also go to Heifer Project International (HPI), Bamenda.

References

- [1] Rondro Mamitiana Ramahefarisoa, Maherintsoa Rakoton Drazaka, Ronan Jambou, Carod JF. Comparison of ELISA and PCR assays for the diagnosis of porcine cysticercosis. *Vet Parasitol* 2010; **173**(3/4): 336–339.
- [2] Willingham AL, Dirk E. Control of *Taenia solium* cysticercosis/taeniosis. *Adv Parasitol* 2006; **61**: 509–566.
- [3] Ngowi HA, Kassuku AA, Maeda GEM, Boa ME, Carabin H, Willingham III AL. Risk factors for the prevalence of porcine cysticercosis in Mbulu District, Tanzania. *Vet Parasitol* 2004; **120**(4): 275–283.
- [4] Marshall W, Lighthowers. Eradication of *Taenia solium* cysticercosis: A role for vaccination of pigs. *Int J Parasitol* 2010; **40**(1): 1183–1192.
- [5] Praet N, Rodriguez–Hidalgo R, Speybroeck N, Ahounou S, Benitez–Ortiz W, Berkvens D, et al. Infection with versus exposure to *Taenia solium*: what do serological test results tell us? *Am J Trop Med Hyg* 2010; **83**: 413–415.
- [6] Kirezi Kanobana, Praet N, Kabwe C, Dorny P, Philippe Lukanu, Madina J, et al. High prevalence of *Taenia solium* cysticercosis in a village community of Bas–Congo, Democratic Republic of Congo. *Int J Parasitol* 2011; **41**: 1015–1018.
- [7] De Giorgio CM, Medina MT, Durón RM, Zee C, Escueta SP. Neurocysticercosis. *Epilepsy Curr* 2004; **4**: 107–111.
- [8] Preux PM, Druet–Cabanac M. Epidemiology and aetiology of epilepsy in sub–Saharan Africa. *Lancet Neurol* 2005; **4**: 21–31.
- [9] Helena A Ngowi, Ayub A Kassuku, Helene Carabin, James ED Mlangwa, Malongo RS Mlozi, Boniface P Mbilinyi, et al. Spatial clustering of porcine cysticercosis in Mbulu District, Northern Tanzania. *PLoS Negl Trop Dis* 2010; **4**(4): e652.
- [10] Siddhartha Mahanty, Garcia HH, Cysticercosis Working Group in Perú. Cysticercosis and neurocysticercosis as pathogens affecting the nervous system. *Progress Neurobiol* 2010; **91**(2): 172–184.
- [11] CIRAD. Porcine cysticercosis in northern Tanzania. <http://pigtrop.cirad.fr> 2011a
- [12] Krecek RC, Michael LM, Schantz PM, Ntanjana L, Smith MF, Dorny P, et al. Prevalence of *Taenia solium* cysticercosis in swine from a community–based study in 21 villages of the eastern Cape Province, South Africa. *Vet Parasitol* 2008; **154**(1/20): 38–47.
- [13] Waiswa C, Fevre EM, Nsadh Z, Sikasunge CS, Willingham III AL. Porcine cysticercosis in South–East Uganda: Seroprevalence in Kamuli and Kaliro Districts. *J Parasitol Res* 2009. Doi:10.1155/2009/375493.
- [14] Medina MT, Aguilar–Estrada RL, Alvarez A, Durón RM, Martínez L, Dubón S, et al. Reduction in rate of epilepsy from neurocysticercosis by community interventions: the Salamá, Honduras study. *Epilepsia* 2011; **52**(6): 1177–1185.
- [15] Carabin, H, Krecek R, Cowan LD, Michael L, Foyaka–Sibat H, Nash T, et al. Estimation of the monetary burden of *Taenia solium* cysticercosis in the Eastern Cape, South Africa. *Trop Med Int Health* 2006; **11**: 906–916.
- [16] Dorny P, Vercammen F, Brandt J, Vansteenkiste W, Berkvens D, Geerts S. Sero–epidemiological study of *Taenia saginata* cysticercosis in Belgian cattle. *Vet Parasitol* 2000; **88**: 43–49.
- [17] Sokal RS, Rohlf JJ. *Biometry: the principles and practice of statistics in biological research*. 2nd Ed., New York: Freeman; 1981, p. 895.
- [18] Ngowi HA, Kassuku AA, Carabin H, Mlangwa JED, Mlozi Malongo RS, Mbilinyi BP, et al. Spatial clustering of porcine cysticercosis in Mbulu District, Northern Tanzania. *PLoS Negl Trop Dis* 2010; **4**(4): 1–13.
- [19] Shey–Njila O, Zoli Pagnah A, Awa JN, Assana E, Byambas P, Dorny P, et al. Porcine cysticercosis in village pigs of North–West Cameroon. *J Helminthol* 2003; **77**: 351–354.
- [20] Praet N, Kanobana K, Kabwe C, Maketa V, Lukanu P, Lutumba P, et al. *Taenia solium* cysticercosis in the Democratic Republic of Congo: how does pork trade affect the transmission of the parasite? *PLoS Negl Trop Dis* 2010; **4**: e817.
- [21] Sathyanarayanan V, Sambhaji C, Saravu K, Razak A, Polnaya A, Rao SN. A rare case of hepatic cysticercosis. *Asian Pac J Trop Biomed* 2011; **1**(Suppl 1): S139–S140.
- [22] Rakotoarivelo RA, Andrianasolo RL, Ranoharison D, Rakoto ROS, SendrasoaFA, MJ de Dieu Randria. Neurocysticercosis as an important differential of paradoxical response during antituberculosis therapy in HIV–negative patient. *Asian Pac J Trop Dis* 2011; **1**(4): 333–334.
- [23] Gill M, Boombak E, Gill PS, Gupta V, Sen R. Extensive cardiac cysticercosis—an interesting autopsy finding. *Asian Pac J Trop Dis* 2011; **1**(4): 335–336.
- [24] Sreedevi C, Hafeez M, Subramanyam KV, Anand kumar P, Chengalva Rayulu V. Development and evaluation of flow through assay for detection of antibodies against porcine cysticercosis. *Trop Biomed* 2011; **28**(1): 160–170.
- [25] CIRAD. Prevalence of porcine cysticercosis in Cameroon and Chad. [Online]. Available from http://pigtrop.cirad.fr/subjects/quality_and_food_safety/prevalence_of_porcine_cysticercosis_in_cameroon_and_chad [Accessed on 2011].
- [26] Vitin Shulkla, Venkatrsh Vimala, Masood Jamal, Mazhar Husain. Seroprevalence of cysticercosis in North Indian population. *Asian Pac J Trop Med* 2010; **3**(8): 589–593.
- [27] Praet N, Speybroeck N, Rodriguez–Hidalgo R, Benitez–Ortiz W, Berkvens D, Brandt J, et al. Age–related infection and transmission patterns of human cysticercosis. *Int J Parasitol* 2010; **40**(1): 85–90.