

Study of the Prevalence, Risk Factors and Economic Losses Caused by Swine Cysticercosis in Animals Slaughtered in the Dedougou Communal Slaughterhouse, Burkina Faso

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Abstract

Original Research Article

Swine cysticercosis is a zoonotic disease transmissible from pigs to humans. In Burkina Faso, few scientific studies have been performed on this pathology, especially in slaughterhouses which are the main production sites of meat destined to human consumption. This study was carried out in the Dedougou slaughterhouse on 3 350 pigs inspected and diagnosed by tongue and post-mortem examination to assess the prevalence of cysticercosis, its risk factors, and the financial losses incurred by butchers due to seizures operated by the inspectors. Results revealed no cysticercosis-positive pigs by the tongue technique, while the post-mortem inspection detected 25 cases, representing a prevalence of 0.75%, leading to an overall loss of XOF 1 118 425 for the butchers. The incriminating risk factors with a significant effect on disease transmission were sex (p -value = 0.0033) and age (p -value = 0.0183). Given these results, Dedougou's communal authorities and animal health officials should undertake an awareness campaign on the disease and strengthen surveillance measures against illegal slaughter.

Keywords: Swine, meat, cysticercosis, Dedougou's slaughterhouse, Burkina Faso.

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INTRODUCTION

Swine cysticercosis is a helminthosis caused by a plathelminth of the *Taeniidae* family, genus *Taenia*. It is a neglected parasitic disease that is transmitted to humans through the consumption of raw or undercooked meat. It thus causes serious public health problems and negative consequences on health and livelihoods in rural communities of developing countries in Africa, Asia and Latin America (WHO, 2018). Currently this pathology is becoming a global problem due to the migration of asymptomatic carriers of adult *taenias* from endemic areas (Zammarchi *et al.*, 2013).

In Africa, swine cysticercosis probably occurs in all sub-Saharan countries except those where pig breeding and especially pig consumption is a religious

taboo (Assana *et al.*, 2001). In this part of the African continent, it causes heavy economic losses in pig production and is the main cause of human epilepsy (Porphyre *et al.*, 2015).

In Burkina Faso, pigs breeding is a key sector with a population estimated to 3 039 500 animals and a business turnover of approximately XOF 43 billion per year (FAO, 2012). The pigs breeding system is essentially extensive and more than 60% of the livestock is owned by women. This activity thus constitutes a major economic stake in view of its socio-economic importance in the lives of the most disadvantaged groups of the population, especially women. However, its development is confronted to numerous constraints, including pathological ones that handicap the optimal profitability of the farms. Among these pathological constraints, cysticercosis is a real

public health scourge and represents the most common reason for total and partial seizure during controlled slaughter (FAO, 2012). Despite the economic and sanitary importance of this disease, the level of infestation remains little known in some regions of the country such as the Boucle of Mouhoun region which is the third largest pig breeding region with a population of about 235 695 pigs. In this region, 27.5% of households practice pigs breeding (FAO, 2012). In view of the importance of this breeding and the consumption of pig meat in this region, an investigation is necessary to make an inventory of cysticercosis in order to take the appropriate measures for its control. The present study was undertaken in this context to evaluate the prevalence and determine the risk factors of the pathology in pigs as well as the economic impact suffered by butchers in the urban commune of Dedougou in Burkina Faso.

MATERIALS AND METHODS

Study area

The study was conducted at the refrigerated slaughterhouse in the urban commune of Dedougou in Burkina Faso. This slaughterhouse is built on an area of four hectares and was opened on October 1, 2002. With a capacity of five hundred tons of meat per year, this slaughterhouse includes a building including the inspection officer's office, the guard's premises and the hygiene officer's premises. It also includes a central building with three slaughter lines, one for cattle, one for small ruminants and one for pigs, donkeys and horses. Inside this building, there is a cold room with a capacity of one hundred and twenty-five cubic meters (125 m³) which is connected to the cattle line. A wastewater evacuation system is also installed and

directed to a settling tank. The slaughterhouse also has an autonomous water supply system for washing the carcasses and cleaning the premises.

Animal material

A total of 3 350 pigs slaughtered at the slaughterhouse from September 2020 to April 2021 constituted our animal material. Interviews with butchers were conducted to gather information about the origin of the animals. The interviews also allowed an estimation of the cost of losses related to seizures operated by veterinary agents at the Dedougou urban commune slaughterhouse.

Inspection methods

Each of the animals was inspected to establish the diagnosis of cysticercosis. The inspection was done by tongue examination (ante-mortem examination) and by post-mortem observations (Sarti *et al.* 1992; Nguekam, 1998; Pouedet, 2001). Tongue examination was done according to the method described by Gonzalez *et al.* (1990). Thus, pigs were physically immobilized in order to search the presence of cysticerci nodules on the tongue of the animals by palpation. During this survey, information on animal breed, sex and age as well as season was collected. Post-mortem inspection was carried out by incising the masseters, heart, buttock muscles (Figure 1-A and B), diaphragm, and tongue to identify cysticerci in accordance with the method described by Dorny *et al.* (2004). Head (picture 1-C), skin, extremities and giblets were also examined following the procedure proposed by Sarti *et al.* (1992). Following this inspection, the pig carcasses, parts or organs affected by cysticerci were seized and destroyed by incineration.

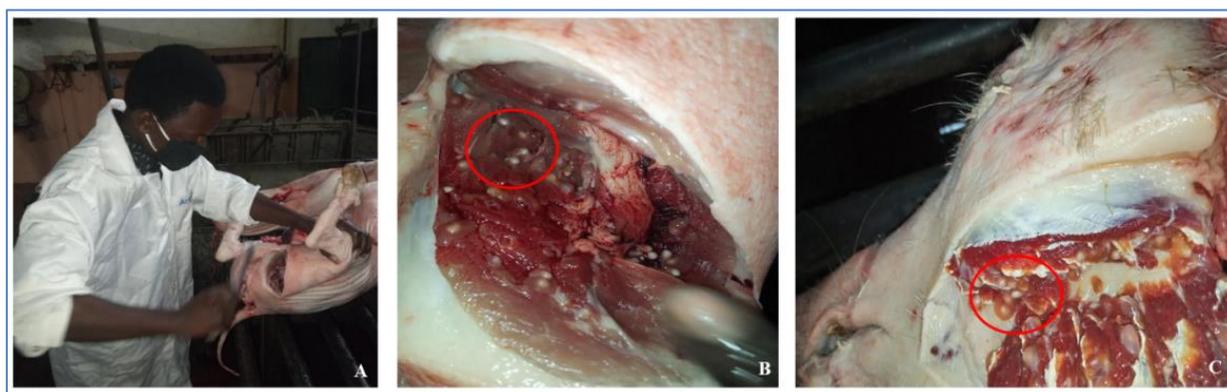


Photo-1: Post-mortem inspection

A corresponds to gluteal muscle incision; B corresponds to an example of infested gluteal muscles; C corresponds to an example of infested masseters; Red-bordered circles indicate cysticerci.

STATISTICAL ANALYSIS

The data collected was used to calculate the prevalence of cysticercosis in pigs, i.e. the ratio of the number of positive cases to the total number of animals inspected (estimated as a percentage). The data collected were also used to assess the main risk factors

of swine cysticercosis (breed, sex and age of animals, season and month). Statistical analyses of comparison were performed by the Chi-square test at the 5% threshold using R software.

RESULTS

1- Prevalence of cysticercosis in inspected pigs

Among the 3 350 pigs slaughtered and inspected, 25 pigs showed cysticerci, representing a prevalence rate of 0.75% diagnosed by the post-mortem

inspection method compared to a zero prevalence (0%) with the tongue examination. This condition was the leading cause of seizures and the single cause of total seizures during the study period (Figure 1).

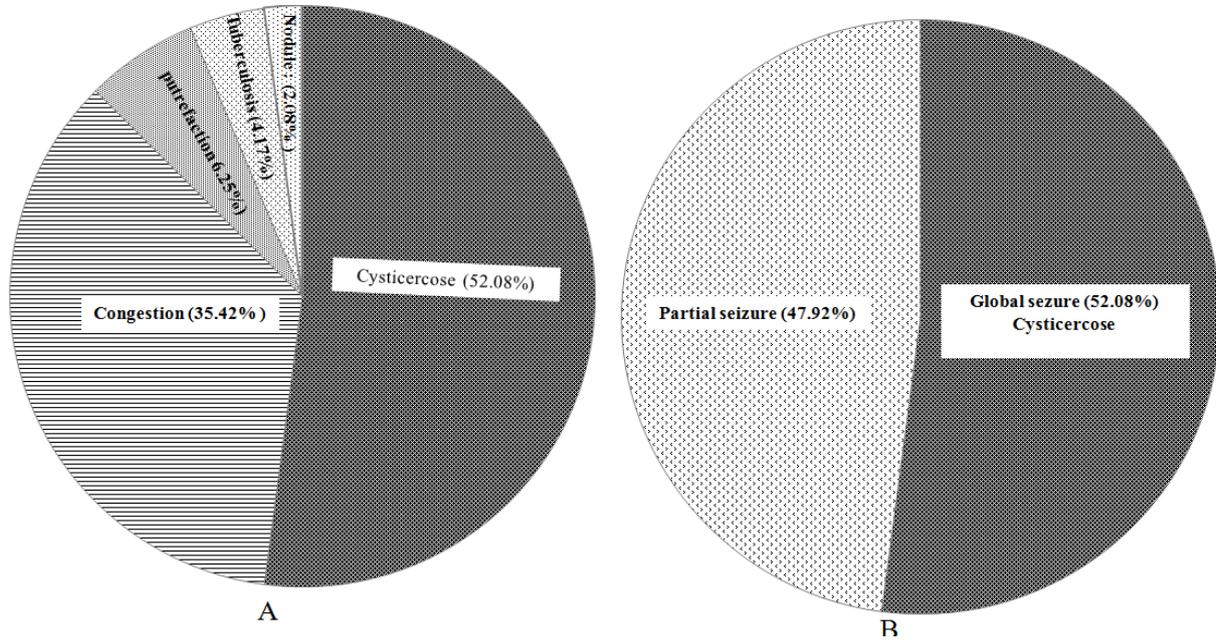


Fig-1: Importance of cysticercosis in pig seizures at the Dedougou slaughterhouse.

A corresponds to the distribution of all the seizures operated at the slaughterhouse during the study while B corresponds to the distribution according to the seizure types

The infested pigs came from 14 sites; including 12 sites in the urban commune of Dedougou (20 infested pigs). The villages of Tikan (4), Massala (3) and Tricongo had the highest numbers of infested

pigs (Figure 2). Infested pigs had an average body condition score (BCS) of 3.48 ± 0.71 with absolute values ranging from 2 to 5 (Figure 3).

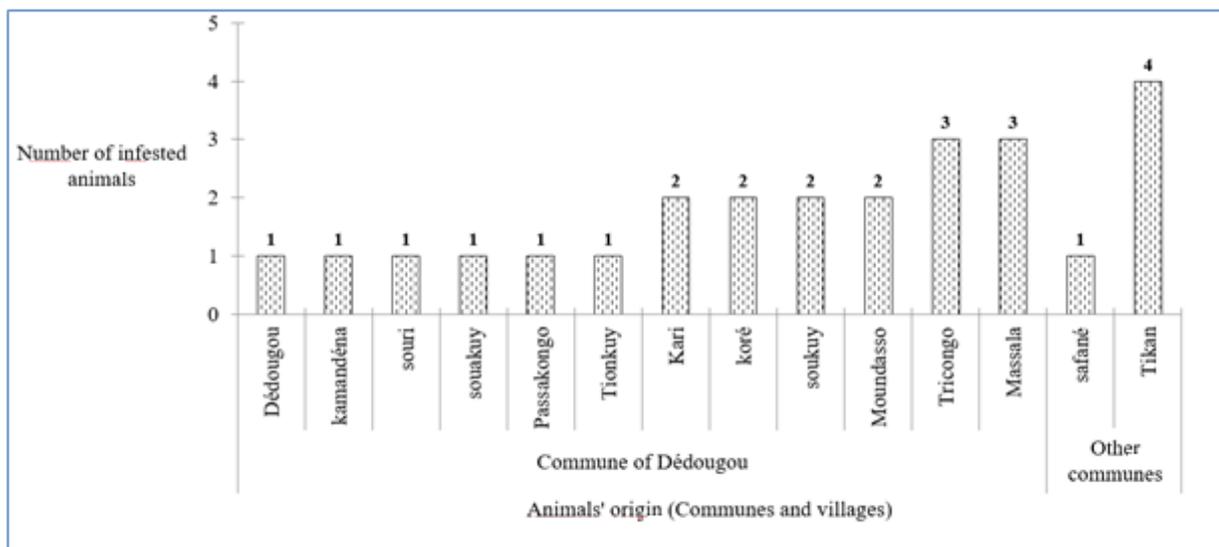


Fig-2: Origin of infested pigs in the Dedougou urban commune slaughterhouse

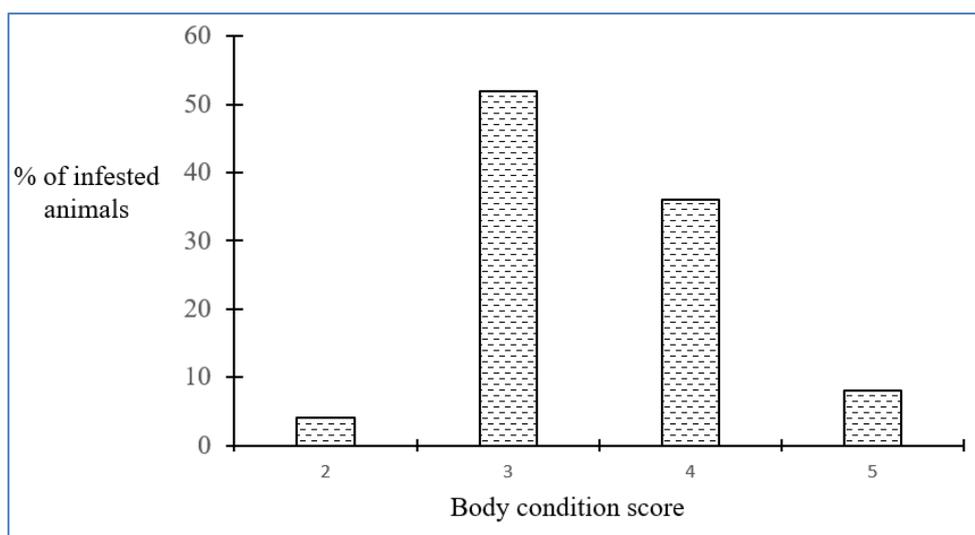


Fig-3: Distribution of infected pigs at the Dedougou slaughterhouse according to body condition score

2- Effects of the risk factors studied

Effect of season on cysticercosis transmission

The average seasonal prevalence of cysticercosis is presented in Table 1. Apparently, the

cold dry season is the least infesting period of the year followed by the hot dry season. The rainy season had the highest prevalence (0.89%). However, the differences observed were not significant ($p > 0.05$).

Table-1: Prevalence of swine cysticercosis as a function of season

Season	Number of inspected pigs	Number of infested pigs	Prevalence (%)	P-value
rainy Season	677	6	0.8863±0.7153	
cold dry Season	1608	11	0.6841±0.5736	0.877
Hot dry Season	1065	8	0.7512±0.2766	

Effect of month on cysticercosis transmission

The mean monthly prevalences ranged from 0.2331±1.18% to 1.4793±3.12% (Figure 4). At first

sight, the effect of month was not significant ($p < 0.05$). However, the mean prevalences in October and January were slightly higher.

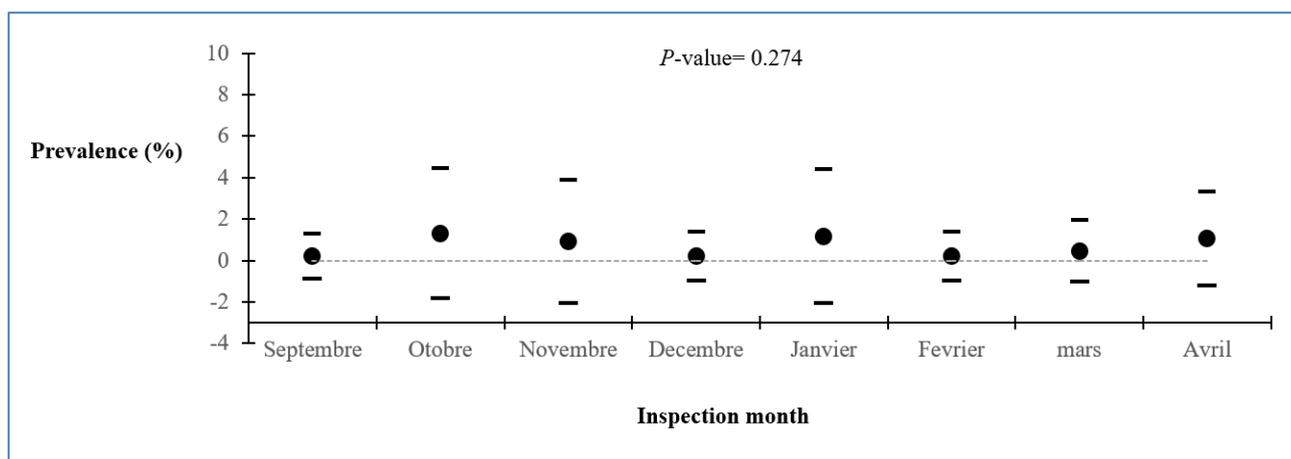


Fig-4: Average monthly prevalence of cysticercosis at Dedougou slaughterhouse

The P-value of the chi-square test (p) at the 5% threshold is provided. The intervals correspond to the upper limit (mean + standard error) and lower limit (mean - standard error) of the prevalence for each month.

Effect of race

The pigs slaughtered during this study were mainly from local breed (3315 pigs or 98.97%). However, the large white (12 pigs) and the mixed breed

resulting from the crossing of this breed with the local breed (23 pigs) were also encountered. Concerning the infestation, all the incriminated pigs were from the local breed, representing a prevalence of 0.7542% compared

to 0% for the other two breeds as large white and mixed breed (Table 2). No significant difference was observed between these values (p -value>0.05), suggesting then

that regarding the breed of pigs, there is no predominance to the susceptibility of swine cysticercosis.

Table-2: Prevalence of porcine cysticercosis according to the breed of inspected pigs

Races	Number of inspected pigs	Number of infested pigs	Prevalence (%)	P-value
Large white	12	0	0	0.878
mixed	23	0	0	
Local	3315	25	0,75	

Effect of sex

From the 3350 pigs slaughtered, more than ¾, being 2521 were males while 829 were females. Post mortem inspection revealed 12 males with cysticerci, corresponding to a prevalence of 0.047 and 13 females,

thus a prevalence of 1.57%. These results are presented in figure 5 showing that the values were significantly different (p -value = 0.0037). The females are therefore more exposed to the germs of the disease.

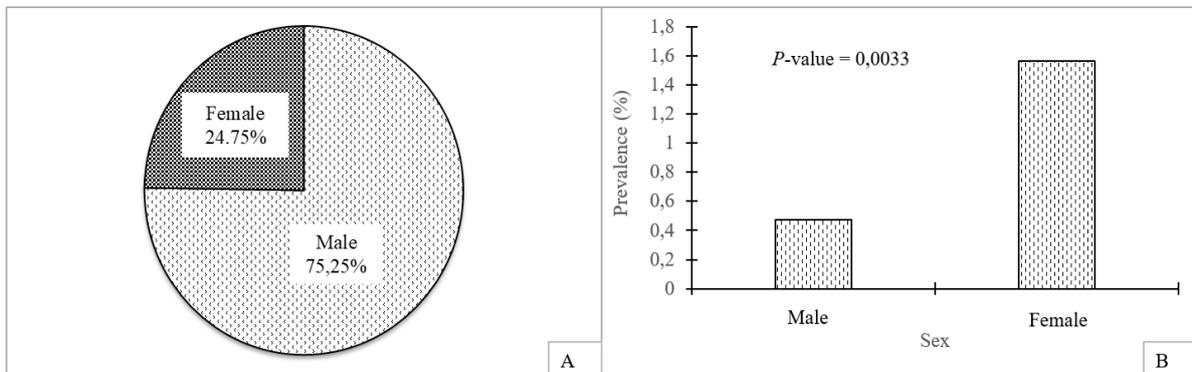


Fig-5: Distribution of pigs slaughtered at the Dedougou slaughterhouse and prevalence according to sex

A: proportion (%) of pigs slaughtered according to sex and B: prevalence of infestation of pigs according to sex. In B, the probability of the chi-square test (P-value) at the 5% threshold is provided.

Effect of animals' age

Of the 3,350 pigs slaughtered, 905 were less than two years old while the remaining 2,445 were between 2 and 5 years old. The prevalence of cysticercosis in young pigs was 1.43%, i.e. 13 cases of pigs infested by cysticerci out of 905 inspected pigs,

compared to a prevalence of 0.49% in adults, corresponding to 12 cases out of 2,445 diagnosed pigs at least 2 years old. These values were significantly different (P -value= 0.0123) (Figure 6) suggesting a higher exposure of pigs less than two years of age.

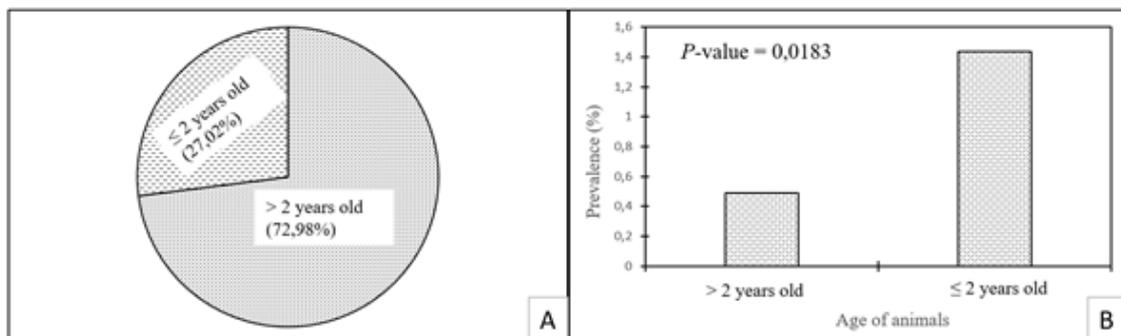


Fig-6: Distribution of pigs slaughtered at the Dedougou slaughterhouse and prevalence according to age

A: proportion (%) of pigs slaughtered according to age and B: prevalence of pigs infestation according to age. In B, the probability of the chi-square test (P-value) at the 5% threshold is provided.

3- Economic loss due to seizures

All 25 pigs with cysticercosis were completely seized according to the level of infestation (photo 1). No partial condemnation (organs) was performed during the study period. According to the butchers working in the slaughterhouse, the average purchase price was XOF 30 720 per pig. The total purchase cost of these pigs was therefore XOF 768 000. The total weight of carcasses seized was 1 016.75 kg, representing a loss of approximately XOF 1 118 425 for butchers, considering the 1 100 XOF cost per kg of pig meat in the urban commune of Dedougou.

DISCUSSION

The results of the present study did not reveal any cases of cysticercosis by the tongue examination method, which inspects only one organ, the tongue. However, in contrast to the present result, this method has provided a conclusive diagnosis in other studies (Pouedet, 2001; Mebanga, 2003 and Mopoundza *et al.*, 2019). Nevertheless, the present results do not imply that this method is ineffective. In fact, exchanges carried out with butchers revealed that they use the tongue examination method to diagnose the animals before purchasing them for slaughter in order to minimize their losses. Our results confirm this observation and show that most of the butchers in the Dedougou slaughterhouse have well mastered this diagnostic method.

The prevalence by post mortem examination (0.75%) was higher than that observed with the tongue examination method. This finding is in accordance to the results of Mopoundza *et al.*, (2019) and could be explained by the fact as post mortem examination allows an easy detection of cysts both in case of massive infestations and lightweight infestations.

The infestation rate observed in our study is slightly higher than the rate of 0.22% observed at the Ouagadougou slaughterhouse in Burkina Faso by Dahourou *et al.* (2018). It is also higher than the prevalences of 0.1% and 0.2% found respectively in Southern Senegal and in Gambia by Secka *et al.* (2010). However, the present rate is lower than the rates of post-mortem infection found in other African countries such as, Benin (0.87%) (Goussanou *et al.*, 2014), Congo Brazzaville (1.69%) (Mopoundza *et al.*, 2019), Madagascar (4.6%) (Porphyre *et al.*, 2015), Kenya (5.6%) (Eshitera *et al.*, 2012), in Zambia (20%) (Phiri *et al.*, 2003) and northern Cameroon and southwestern Tchad (34%) (Assana *et al.*, 2001).

The health status of the infected pigs showed that a pig could have a body condition score of 5 and still be parasitized as the body condition score of the infested animals ranged from 2 to 5. This observation suggests that the animals transported to the

slaughterhouse were adequately fed, given their average body condition score which was 3.48. Indeed, the Boucle of Mouhoun Region is an excellent agricultural region. The animals, which are mostly roaming, especially in the dry season, enjoy the fields after harvest, as well as the dry grass. In addition, breeders sometimes give to animals the feed supplements such as draff and bran (MRA, 2003). This would also explain pigs' tolerance to the presence of cysticerci, as they do not get sick from them.

Twenty four (24) of the infested animals came from the villages neighboring Dedougou city. Only one case was coming from this city. These results could be partly explained by the livestock system practiced in these villages. According to FAO (2012), pig breeding in rural areas of Burkina Faso is essentially traditional, compared to the cities where breeders increasingly use improved breeds such as Large White and Korhogo which are raised in confinement. Moreover, the sanitation level is relatively better in urban areas than rural areas. In fact, about 52.2% of the population in rural areas practice open defecation (Dahourou, 2017). This contributes greatly to the maintenance of the parasite life cycle and the spread of germs in these settings.

Analysis of the collected data reveals the existence of disease during the entire study period covering both the rainy season (September and October), the cold dry season (November to February) and the hot dry season (March and April). However, slight no-significant differences (P -value > 0.05) of pathology prevalence were observed between the three seasons. Indeed, the prevalence of pathology in the study was higher, in the rainy season (0.88%) than in the hot dry season (0.75%) and cold dry season (0.68%). This finding could be explained through the fact that the rainy season is more favorable to the development of the parasite. Indeed, according to Murrell *et al.* (2005), the humidity during the rainy season and rainwater contribute to the propagation of cysts contained in human defecation, thus exposing animals. In dry seasons, the absence of water runoff and rainfall reduces the expansion of the parasite causing a decrease of prevalence during this period, but infestation still occurs because of human defecation in the open air and poor living conditions (Sreedevi *et al.*, 2012). Moreover, during this period, there are isolated infestation areas represented by some pigsties which are used as latrines by the population, especially children (Dahourou, 2017).

All infested pigs were from local breeds. This result could be attributed to the fact that this breed is essentially bred in an extensive system, especially in rural areas, in contrast to the mixed and exotic breeds, which are generally kept in confinement or semi-confinement (MRA, 2003) and hence little exposed to

parasites. In these modern and semi-modern systems the existence of a fairly good prophylaxis restricts the contact between the animals and the infestation pathogens.

The prevalence varied significantly between sexes with 0.47% for females compared to 1.55% for males. These results are different from those obtained by Mopoundza *et al.*, (2019) who obtained 2.08% for females and 1.46% for males in Congo Brazzaville. The difference could be explained by the breeding system, which is more than 90% traditional in Burkina Faso, where males are generally sold to satisfy family needs and therefore do not stay long in the farm. However, female animals are kept for breeding till they reach a given number of years before being replaced. Their duration in the farms and the long distances they travel for feeding increase their risk of exposure to the pathology germs.

The prevalence was higher in pigs under two years age (1.43%) compared to those over two years age (0.49%) in our study. These results could be explained by the fact that the young pigs that are led by the females are as exposed as them. However, these results are contrary to those of Assana *et al.* (2001) who found a prevalence of 30.5% for adults and 3.6% for young in Mayo-Kebbi in south-western Tchad because of the follow-up of pigs from birth to adulthood by breeders in their study area. Likewise, their observations corroborated those of Pondja *et al.* (2010) and Ngwing *et al.* (2012) who noted that the prevalence of the disease in pigs increased with age.

Regarding condemnations, cysticercosis was the first cause of pig seizures at the Dedougou slaughterhouse. These seizures generated a loss of 1 016.75 kg of pig meat during the full study period, representing a daily loss of 4.36 kg of meat. In economic value, this loss is estimated to be XOF 1 118 425 for study period. With an average of eleven butchers at the Dedougou slaughterhouse, the loss is estimated to 92.43 kg of meat per butcher, or a loss of 0.39 kg of pig meat/utcher/day so 11.9 kg of pork/butcher/month. These losses are estimated at XOF 13 090 per month per butcher, showing a significant decrease in their purchasing power. In other parts of the country, notably Ouagadougou and Bobo-Dioulasso, the estimated losses were relatively high. They were XOF 2 398 500 for the Ouagadougou slaughterhouse (Dahourou *et al.*, 2018) and XOF 25 715 448 for the Bobo-Dioulasso slaughterhouse (Dahourou *et al.*, 2016). Important economic losses due to cysticercosis have also been revealed in other African countries. This is the case in Ghana at the Kumasi abattoir where the loss was estimated at \$29 035 (Atawalna *et al.*, 2015) or about XOF 16 818 523.75. The differences are probably due to the duration of studies and the size of the slaughtered animals in these slaughterhouses. Furthermore, in the present study, the economic losses

were probably underestimated. In fact, no animal presented at the slaughterhouse in Dedougou showed cysticerci on the tongue, thus attesting to the knowledge of the pathology and the mastery of the tongue examination technique by butchers and probably breeders. Only animals without signs of infestation are so taken to the slaughterhouse to avoid losses due to seizures by veterinary inspectors. These observations were confirmed by the work of Dahourou (2017), who estimated losses related to swine cysticercosis to be XOF 79 680 803 for the overall Boucle of Mouhoun region through a socio-economic survey on the disease.

CONCLUSION

The results of the study allowed the estimation of swine cysticercosis prevalence in Dedougou's slaughterhouse it also allowed the determination of the potential risk factors of disease contraction, such as animals' sex and age. The cases of infestations were found throughout the study period, showing the importance of this neglected disease in the region. Given the results of this study and the zoonotic nature of cysticercosis, it is imperative to (i) sensitize the population, particularly pig breeders, on the existence of cysticercosis and the measures required to reduce the infestation rate by using good breeding practices, (ii) to sensitize butchers on the zoonotic nature of this pathology in order to avoid illegal slaughtering and contamination of consumers in the urban commune of Dedougou in Burkina Faso. Animal health authorities should also promote deworming and disinfection on animal farms, focusing on females and young pigs.

Conflict of interest

The authors declare that there is no conflict of interest

Authors' contributions

The contributions of the various authors were as follows:

- SERE Modou, Assistant Professor at the University of Dedougou, contributed to the design of the study and the writing of this article;
- KAN Saturnin Yorossi, a student at the end of his engineering studies, contributed to the collection of data and the writing of this article;
- POODA Sié Hermann Assistant Professor at the University of Dedougou contributed to the design of the study and the writing of this article
- KABORE Benoît, Livestock Technician, contributed to the collection of data and the writing of this article;
- KABORE Adama, Director of Research contributed to the design of the study, the writing of this article and the supervision of the work;

- TAMBOURA H Hamidou, Director of Research contributed to the design of the study, the writing of this article and the supervision of the work;
- BELEM Adrien Marie Gaston, Professor at the Nazi Boni University of Bobo-Dioulasso contributed to the design of the study, the writing of this article and the supervision of the work;

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