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Farmers' awareness and ethno-veterinary practices regarding porcine cysticercosis in the province of Boulkiemde, Burkina Faso

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Porcine cysticercosis is a major public health issue in Burkina Faso. This study investigated farmers' awareness and ethno-veterinary practices regarding this disease in Boulkiemde province, Burkina Faso. A survey was done with 132 randomly selected pig farmers in 10 villages of two municipalities of Boulkiemde province, using a semi-structured questionnaire. The majority of interviewed farmers (54%) were from the Koudougou municipality and female (77%). The average number of pigs per farm was 5.4, and all pigs were roaming free during the dry season. All farmers already heard about porcine cysticercosis and the condition had various names in local languages in the study area. In the area, 66% of farmers observed porcine cysticercosis in their pigs, and among them 85% have noted cysticercosis cases in their farms during a period of six months before the survey. During the survey, farmers stated that, on average, infected pigs lost 62% of their market value. Among farmers, 77% knew some traditional treatments based on plants. Fourteen plants species were documented as used in the treatment of this disease. The most commonly used plant species is *Parkia biglobosa*, with a frequency index of 37%. In general, the leaves (44%), bark (30%), seeds (23%) and roots (3%) are used in treatments that are administered only orally.

Key words: Burkina Faso, Sabou, Koudougou, *Tænia solium*, plant, treatment.

INTRODUCTION

Ethnoveterinary medicine is relevant in rural communities where animal husbandry is the primary means of

Subsistence (Miara et al., 2019). About 80% of African population depends until today on traditional medicine for

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prevention and treatment of several human and animal diseases (Burton et al., 2015; Aziz et al., 2018). In Burkina Faso, livestock rearing is one of the main economic activities on which the poorest populations depend for food and income. Given the limited consumption of animal source foods in many African countries, pork and avian productions are considered as an interesting option to address protein deficiency (FAOSTAT, 2014). In Burkina Faso, West-Center region has the highest pig population in the country with 456,736 pigs representing about 20% of the national population (FAO, 2012). Local breeds are mostly used in traditional farming systems where pigs are tied up or kept in small houses during the rainy season but left to roam freely in the dry season (Umutoni, 2012). However, one of the major constraints of pig-keeping in rural areas of low-income countries is the existence of parasitic zoonoses. Among those zoonotic diseases, *Taenia solium* cysticercosis is considered a public health and economic problem in many developing countries (Ngowi et al., 2017; Braae et al., 2016; WHO, 2016; Johansen et al., 2014). It is seriously affecting pig production and leads to significant economic losses such as reduced market value from the food chain (Praet et al., 2009; Krecek et al., 2012; Adenuga et al., 2018). According to the World Health Organization (WHO), *T. solium* is the cause of 30% of acquired epilepsy cases in endemic regions areas of Asia, Latin America and Africa, where pig management practices are poor (WHO, 2015; Aung and Spelman, 2016; Mwabonimana et al., 2020). In Burkina Faso, a significant association between epilepsy and cysticercosis has been demonstrated by Nitiéma et al. (2012) with about 29% of epilepsy cases due to neurocysticercosis (Millogo et al., 2012). As regards farmers' knowledge on *T. solium*, sometimes people are aware of the disease which has different names in local languages. According to Dahourou et al. (2018), more than half of farming in Boucle du Mouhoun region in Burkina Faso (60.3%) has already seen a swine-infected carcass. In the provinces of Boulkiemdé, Sanguié and Nayala, Ngowi et al. (2017) reported that 63.4% of people have already seen pigs carcasses infected by *T. solium* cysts. However, the transmission routes and the methods of sanitizing the infested meat are unknown by the majority of people (99.4%) in Boucle du Mouhoun region (Dahourou et al., 2018). In the study of Ngowi et al. (2017) in Burkina Faso, only 5.3% of people know that the infestation of taeniasis is associated with the consumption of uncooked infected pig meat. Ngowi et al. (2017) in Burkina Faso found respectively, that 33.7 and 6.2% of the population know that porcine cysticercosis is linked to the consumption of human feces by pigs.

The strategy to eliminate taeniasis is based on community education in combination with a multipronged approach consisting of vaccination of pigs using TSOL18 vaccine and anthelmintic treatment along with mass chemotherapy of humans with praziquantel. In terms of

health, majority of breeders do not take care of their animals and preventive care is therefore almost absent (Youssao et al., 2008). On the other hand, in rural areas, pastoralists use their endogenous knowledge such as using of plants or other traditional products for animal care (Missohou et al., 2001). In many African countries, most of the population often uses plants for health care (Miara et al., 2019). In Burkina Faso, many herders use ethnoveterinary knowledge for animal health care either for their efficacy or for easy accessibility (Kabore, 2009). Medicinal plants could be an alternative to control *T. solium* cysticercosis (Tamboura et al., 1998). Nonetheless, ethnoveterinary practices against porcine cysticercosis are under-documented (Yahya et al., 2016). In Burkina Faso, studies focused on ethnoveterinary practices against swine cysticercosis are very limited and only the study of Tamboura et al. (1998) described some medicinal plants used for the treatment of helminthes infections in general. This study was undertaken to understand farmers' awareness and their ethno-veterinary practices against swine cysticercosis in the province of Boulkiemdé in Burkina Faso.

MATERIALS AND METHODS

Study area

The study was carried out in 10 villages in the municipalities of Koudougou and Sabou in the province of Boulkiemdé (2°21'51" west longitude and 12°15'3" north latitude) (Figure 1). This area has a northern Sudanese climate with an average rainfall of around 800 mm per year (Bationo et al., 2004). The vegetation is composed of savannah and forest galleries (Tiendrebeogo, 2013) and an area that belongs to the northern Sudanian sector characterized by the presence of grassy, shrub and tree savannas. The savannahs present everywhere the allure of rustic landscapes dominated by local consumable fruit species such as *Vitellaria paradoxa*, *Sclerocarya birrea*, *Lannea microcarpa*, *Balanites aegyptiaca* ... (Tiendrebeogo, 2013). The dominant species are: *Combretum paniculatum*, *Guiera senegalensis* and companion species such as *Saba senegalensis*, *Anogeissus leiocarpus*, *Diospyros mespiliformis*, *Daniella oliveri*, *Pilostigma reticulatum* (Tiendrebeogo, 2013). The tree layer is dominated by: *Kaya senegalensis*, *Vitellaria paradoxa*, *Azadirachta indica*, *Parkia biglobosa* (Tiendrebeogo, 2013).

Sampling and data collection

Data comprising semi-structured survey by individual interviews were collected from July to September 2019. Ten villages in the province of Boulkiemdé were included in this survey. Face to face interviews were conducted with 132 informants and around 13 pig farmers per village. Although the question was written in French, the interviews were conducted in French or local language. These participants were subjected to a questionnaire that focused on the following items: pig husbandry and human hygiene practices, main pig diseases on the farm and the management system, knowledge, importance and management of porcine cysticercosis in the farm. Data collected was on age, gender, educational status of respondents, main pig diseases on the farm and the management system. Information regarding local plant names, part(s) used,

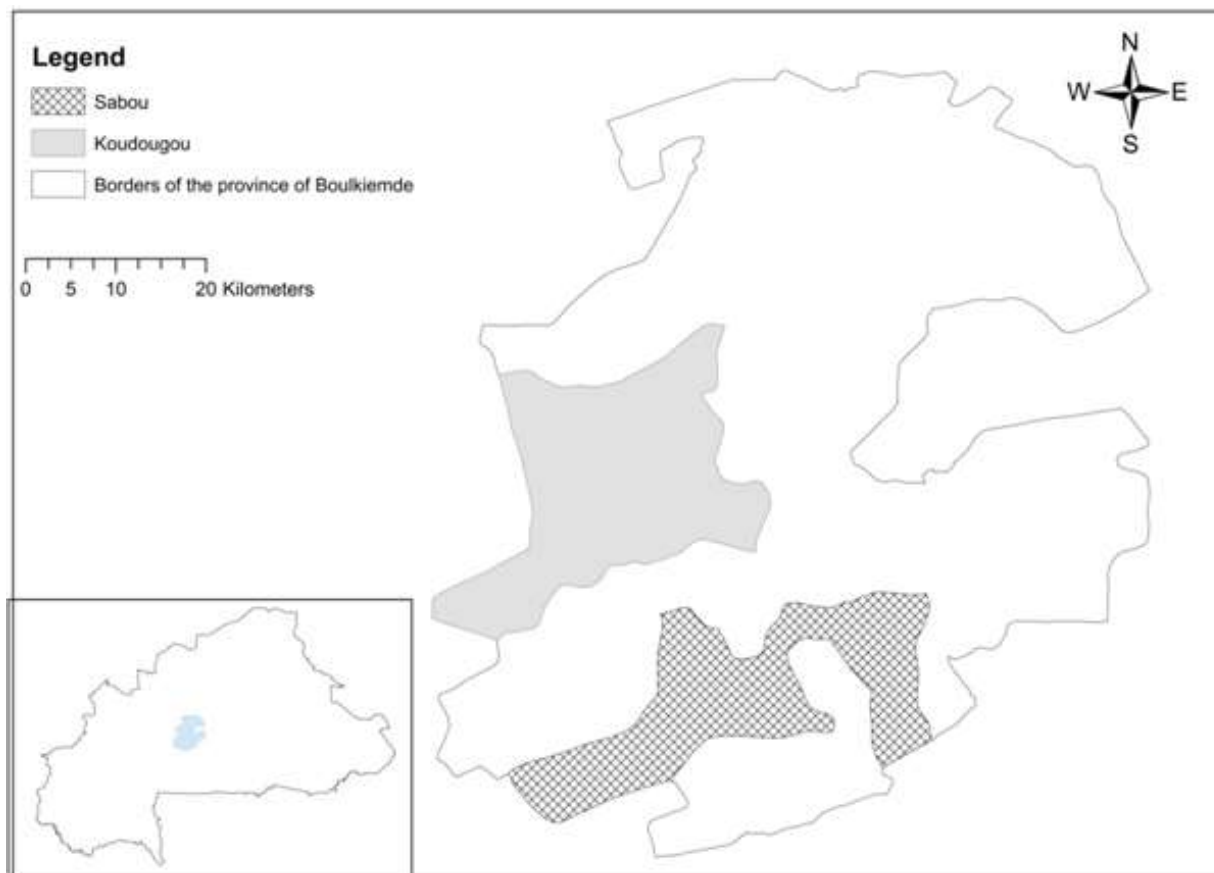


Figure 1. Location of the municipalities of Koudougou and Sabou in the province of Boulkiemdé, Burkina Faso.

methods of preparation and application for the control of porcine cysticercosis was documented.

Data management and statistical analysis

Collected data were entered using the Sphinx software (Sphinx, 2015). The data were subjected to descriptive analysis by calculating frequencies and percentages. As regards use of plants in the treatment of porcine cysticercosis, the frequency index (FI) was calculated according to Mahwasane et al. (2013), by applying the formula: $FI = FC/N \times 100$ with FC: the number of informants who mentioned the use of the plant species and N: the total number of informants in the study area.

Ethical considerations

In each selected household, farmer oral informed consent was obtained before administration of the questionnaire.

RESULTS

Socio-economic characteristics of pig farmers

In the study, 53.8% of the surveyed farmers came from

the Koudougou municipality and were between 40 and 60 years of age (Table 1). Almost half (48.5%) of the surveyed farmers had no formal education. Only (5.3%) had high school level. Women (76.5%) and members of pig farmers' organizations (53.8%) were dominant in the survey. Among all interviewed farmers, 84.8% had agriculture as main activity, while the others (15.2%) were civil servants (0.8%), shopkeepers (0.8%), local beer sellers (6.8%), pig farmers (3.8%) and housewives (3%).

Pig breeding practices and 'pig farmers' awareness and management practices for porcine cysticercosis

The average number of pigs was 5.4 with 3.2 females and 2.2 males per farm. All pigs were free ranging during the dry season, while during the rainy season, pigs were tied (51%) or kept (49%) in pens. On 99% of surveyed farms, kept pigs were from local breed while only 3% of surveyed farms had exotic or mixed-breed breed. Although all these farms experienced outbreaks of African swine fever, only 11% of them applied stipulated health protocols like deworming and respect of

Table 1. Characteristics of pigs' breeders in Boulkiemde province.

Variable	Modality	Number	Frequency (%)
Age	Less than 40 years old	52	39
	40 - 60 years old	63	48
	More than 60 years old	17	13
Origin	Koudougou	71	54
	Sabou	61	46
Gender	Male	31	23
	Female	101	77
Educational level	Alphabetized	31	24
	No formal education	63	48
	Primary school	30	23
	High school	7	5
Main activity	Agriculture	112	85
	Others	20	15

Table 2. Awareness and practices of pigs' farmers surveyed in the study regarding porcine cysticercosis.

Variable	Modality	Number	Frequency (%)
Experience of infection in the farm	Yes	87	66
	No	45	34
Last case in the farm	Less than 6 months	74	85
	More than 6 months	13	15
Purpose of infected pigs	Consumed	22	17
	Immediately sold	110	83
Period of high infection	Dry season	52	41
	Rainy season	4	3
	Whole year	70	56
Knowledge of transmission	Yes	7	5
	No	125	95
Knowledge of <i>language</i> technique	Yes	64	46
	No	68	51
Human health risk associated with the consumption of infected meat	Yes	127	96
	No	2	2
	Do not know	3	2
Consumption of infected meat	Yes	16	12
	No	116	88
Existence of latrine in the household	Yes	96	73
	No	35	27
Using traditional treatment for porcine cysticercosis	Yes	102	77
	No	30	23

Table 3. Plant species and their use in the treatment of porcine cysticercosis by pig farmers surveyed in the study.

Name in local language (Mossi)	Scientific name	Frequency index (%)	Parts used	Preparation mode
Roanga; Lélongo	<i>Parkia biglobosa</i>	37.2	Leaves, root barks, stem barks, seeds	Crush, infuse in water, filter, and use as drinking water (0.5 L/animal/day)
Kouka	<i>Khaya senegalensis</i>	20.2	Leaves, stem barks, seeds	Crush, infuse in water, filter, and use as drinking water (1 L/animal/day) or crush and mix with feed (one handle/animal/day)
Bicalga, Bito	<i>Hibiscus sabdariffa</i>	17.8	Leaves, seeds	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)
Barkudga	<i>Annona senegalensis</i>	8.5	Leaves, root barks, stem barks, seeds	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)
Wilwiga	<i>Guiera senegalensis</i>	3.1	Root barks	Crush and mix with feed (one handle/animal/day)
Nobga	<i>Prunus domestica</i>	2.3	Stem Barks	Boiled barks or infuse in water, filter and use as drinking water (<i>ad libitum</i>)
Tabac	<i>Nicotiana tabacum</i>	2.3	Leaves, stem barks	Infuse in water, filter and use as drinking water (<i>ad libitum</i>)
Sabgha	<i>Lannea microcarpa</i>	2.3	Leaves, stem barks	Infuse in water, filter and use as drinking water (<i>ad libitum</i>)
Taaga	<i>Vitellaria paradoxa</i>	1.5	stem barks and seeds	Infuse in water, filter and use as drinking water (<i>ad libitum</i>)
Baninga	<i>Sorghum bicolor</i>	1.5	Seeds	Boiled and use as drinking water (<i>ad libitum</i>)
Wedda	<i>Saba senegalensis</i>	0.8	Young leaves	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)
Binga	<i>Phaseolus vulgaris</i>	0.8	Seeds	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)
Noinga	<i>Kaya grandifoliola</i>	0.8	Leaves, stem barks	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)
Voaaka	<i>Bombax costatum</i>	0.8	Leaves and seeds	Crush, infuse in water, filter, and use as drinking water (<i>ad libitum</i>)

biosecurity measures. In addition, the respondents also raised goats (30%), sheep (21%) and cattle (11%).

During the survey, all pig farmers affirmed to have heard about porcine cysticercosis, which is called Baninga or Koukouri baninga (Moore language), Yalaor Koukou Yala, Koukou Yabia or Koukou kiin (Gurunsi language).

Most of the breeders (66%) experienced infestation in their pigs, with 85% having observed cases during the last six months (January-June 2019) as shown in table 2. . According to 56% of respondents, the disease occurred 70 times during all seasons, compared to 41.3% who noticed it mainly during the dry season. The mode of transmission of porcine cysticercosis is not known by the majority of farmers (95%) who believe that transmission is associated with heredity (27%), consumption of sorghum (53%),

tree leaves (12%), too salty food (22%), and wandering (67%). According to most of the surveyed respondents (96.2%), the consumption of infected meat is risky for human health. However, 12% of them do consume infected pork. In their households, some respondents used latrines (73%), while others (38%) defecated in the open. This study revealed that an infected pig lost 62% of its market value, although 77% of farmers are aware of traditional treatments for cysticercosis.

Ethno-veterinary practices in the treatment of porcine cysticercosis

In the two study areas of Koudougou and Sabou municipalities, fourteen (14), plant species were used in the treatment of porcine cysticercosis. The

most commonly used plant species is *Parkia biglobosa* with a frequency index of 37% (Table 3). In general, the leaves (most used by 44% of respondents), roots bark (least used by only 3% of respondents), and seeds (23%) (Figure 2) of the plants are used in the treatments that are administered only orally.

DISCUSSION

Socio-economic characteristics of pig farmers

A total of 132 pig-keeping households were visited. Female respondents were predominant and most of breeders were less than 60 years old. It means that females were highly involved in pig production in the study area. Results are in agreement with the observations of Kungu et al.

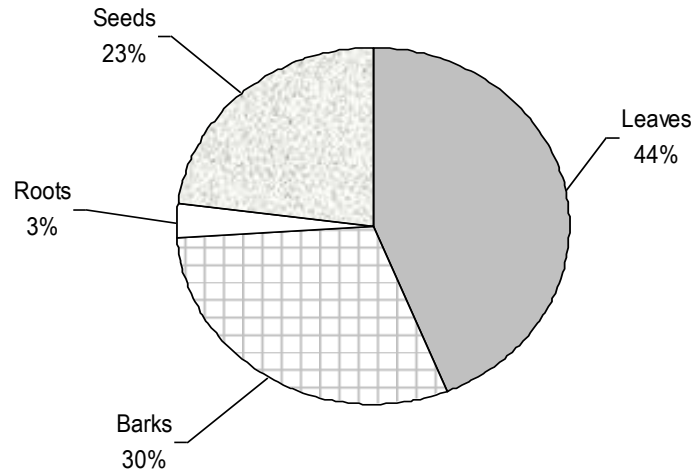


Figure 2. Plant parts used in the treatment of porcine cysticercosis by pig farmers.

(2019) who reported that pigs were kept in small numbers for subsistence mostly by women and children in the northern Uganda. This is also in agreement with FAO data on Burkina Faso (2012). According to FAO, pig-keeping households are mostly important in Boulkiemde (Koudougou) and Sanguié (Sabou) districts of Burkina Faso. About half of them had non-formal education level. Their educational level is sometimes an obstacle to getting well-paying jobs, and as a result, they engage in rural pig farming which provides them an opportunity to improve their income. According to FAO (2012), this breeding concerned mostly women members of local groups or cooperatives. They exercise this activity to generate their own income while other types of livestock (ruminants and poultry) are most times managed by the husband. Pig breeding is primarily an activity of Christian women and animists, because its practice is prohibited by the Muslim religion. However, the results are contrary to the observations of Adesehinwa et al. (2003) who reported that pig production is dominated by men in Southwest Nigeria. For those who practice it, pig breeding is a saving (Rouamba, 1985) and a means of processing agricultural by-products and less valuable residues. They also keep other livestock species in addition to pigs and practice agriculture to diversify their income sources.

About half of respondents were in age class of 40 - 60 years followed by those in age group ≤ 40 . Low respondents were reported in age group > 60 years. All of age class respondents were interested in pig breeds in household with more middle age and young people.

Pig breeding practices and pig farmer awareness and management practices for porcine cysticercosis

This study reported high number of sows in farms.

Female dominance is mainly explained by the fact that few farmers keep boars on their farm. For reproductive purposes, females are sent in a farm with boars and returned in their original farms after mating. Similar findings have been reported in Benin by Djimenou et al. (2017). All pigs were free ranging during the dry season and kept indoors or tied during the wet season. The number of free-ranging pigs was higher in the dry season more than in the rainy one. Pigs wandered throughout the year except for rainy season when they are locked in unsanitary enclosures or tied under a tree or an attic. These pig keeping systems with seasonal patterns have mainly been associated with limited feed resources during the dry season and also to avoid damages on crops (Lekule and Kyvsgaard, 2003). This finding concurs with previous studies in central African countries (Dione et al., 2014; Lekule and Kyvsgaard, 2003), which are in agreement with the observations of Ngowi et al. (2017). Most farmers favored tethering as an alternative to roaming, as they could not afford building proper housing for pigs.

Most of surveyed farms had local breed with low farms having exotic or mixed-breed pigs. Our result on the distribution of pig breeds in this study area is confirmed by the national data (FAO, 2012). Indeed, local pigs are hardy and adapt well to the rustics farming conditions in rural environment which are very widely distributed in Burkina Faso with nearly 90% of the herd (Gampiné, 1985; FAO, 2012). It is the animal of choice in the extensive stray production system where it is exploited as a purebred and sometimes crossed with improved animals. Not very productive and with poor prolificacy, the local breed beats all records in terms of hardiness and ability to adapt to extreme breeding conditions. One part of the pigs breeders are the result of a cross between the local breed and the Large White breed or the Korhogo pig.

The results of this study showed that farmers lack adequate knowledge of porcine cysticercosis. Its transmission modes and impact to humans were not well understood. According to Kungu et al. (2017), the occurrence of cysticercosis is a major public health concern given that breeders have little knowledge of the condition and how to prevent and control it. Appropriate health education of local communities on the transmission cycle of this condition might enhance good practices such as proper hygiene and sanitation, use of water from protected sources, and boiling of drinking water. Traditional rearing systems are practiced by majority of farmers in the study area. However, the stray system increases the likelihood of pigs accessing human fecal matter contaminated with tapeworm eggs, facilitating the completion and maintenance of the transmission cycle of pork tape-worms and cysticercosis (Ganaba et al., 2011; Mwanjali et al., 2013; Carabin et al., 2015; Braae et al., 2015; Thys et al., 2016).

Pigs' breeders are aware of cysticercosis, have experienced infections in their farms and the disease has names in local languages. Unfortunately, most farmers ignored the way pigs get infected as described by Ngowi et al. (2017) in Burkina Faso. This lack of knowledge, could lead to risky behaviors which help to maintain the transmission of the disease to pigs (Sarti et al., 1992). These results are in agreement with the observations by Thys et al. (2016) which indicated that ignorance, poverty, and superstitious beliefs about *T. solium* are associated with increased risk of disease transmission in endemic areas and may prevent them from knowing about tapeworm infections in humans.

This study showed that latrines were available in the majority of households. Though the latrines and toilets were directly observed in the vicinity of homes, most of the people preferred open defecation. The presence of cysticercosis in the study area could be explained by the presence of free ranging pigs during the dry season. The presence of cysticercosis infection is facilitated by the easy access of pigs to human feces. Lack of latrine facilities may also be identified as a significant risk. Ganaba et al. (2011) had reported open defecation, refusal to using the toilet as common practices in Burkina Faso and are habits that promote the spread of *T. solium*.

Ganaba et al. (2011) has shown that in Burkina Faso, the traditional system of pig management, which is a free-range production system for pigs involves being confined or tethered at night and allowed to roam freely during the day. In the dry season, pigs left to roam were more likely to be seropositive than those confined in pens. In this pig production system, poor sanitary conditions play an important role in the circulation of *T. solium* infection. It is estimated that 80% of the pigs of Burkina Faso are still slaughtered by farmers at home and sold without prior meat inspection for cysticercosis (Ganaba et al., 2011).

During this study, some farmers noted that porcine

cysticercosis is mainly observed during dry season while some noted that it is most prevalent on rainy season. The seasonal disparity of the observed infestation according to farmers may be attributed to the different seasonal pig production systems. Indeed, during the dry season after crops have been harvested, pigs are in general left to freely roam while in the rainy season, pigs confined are fed on crops and other foodstuffs locally available. The higher infestation observed in the rainy than in the dry season would explain the likely fact that the eggs of the parasite contaminated some feed during pigs' confinement. It has been shown in a previous study that confinement of pigs as a sole intervention for control does not necessarily prevent porcine cysticercosis (Braae et al., 2014).

In 2011, the prevalence of porcine cysticercosis was estimated to be between 32.5 and 39.6% in Burkina Faso (Ganaba et al., 2011). Traditional breeding systems generally observed in rural areas are likely to influence the prevalence of porcine or human cysticercosis (Ganaba et al., 2011; Secka et al., 2011, Weka et al., 2013). The traditional system of pig management could be a risk factor for transmission of the disease; hence, pig keeping households should be advised to confine their pigs if possible. Providing feeds to the pigs under the confined systems of management runs in opposition to the motivations of smallholder farmers, who engage in pigs breeding as a source of income without the need to invest in feed (Assana et al., 2013)

During the study, different risky practices regarding *T. solium* transmission to humans and pigs have been noted. Even if most of the breeders are aware that consumption of infected meat could lead to human health issues, some of them ate infected meat. This situation seems to be common in the country as Dahourou et al. (2018) have also noted it in Boucle du Mouhoun region (Burkina Faso). Unfortunately, this could lead to *T. solium* transmission to human if meat is undercooked. Studies conducted in West African countries indicated that preparation methods do not effectively kill the cysticerci (Assana et al., 2013). Thus, those who consumed lightly cooked pork soups and those who consumed pork with cysticerci had higher probabilities of taeniasis (Bimi et al., 2012; Weka et al., 2013; Carabin et al., 2015).

In this study, latrines were noted in several households but some breeders practice open defecation which exposes pigs to human feces and increase the risk of *T. solium* transmission to pigs as they roam free during the dry season (Pouedet et al., 2002; Pray et al., 2019).

The study showed that infected meat lost more than half of its market value, which explains the economic importance of *T. solium* cysticercosis as described in different studies in Africa (Trevisan et al., 2018; Dahourou et al., 2016; Nkwengulila, 2014; Assana et al., 2019). A number of such studies have reported reduction of pigs' market value when infected by *T. solium*. Dahourou et al. (2016) have reported a value of 31% in

Boucle du Mouhoun region in Burkina Faso; Praet et al. (2009) reported 30% in Cameroon; Trevisan et al. (2018) noted a reduction of 50% in Mozambique; and a value that ranged from 25 to 56.5% have been noted in Tanzania (Nkwengulila, 2014).

Ethno-veterinary practices in the treatment of porcine cysticercosis

Porcine cysticercosis is quite common in the study area and many breeders use plants for traditional treatment. Unfortunately, ethnoveterinary data for the treatment of *T. solium* cysticercosis in pig remain scarce in West Africa while much information is available for other parts of the world (Bizhani, 2015; Ito et al., 2013). The ethnoveterinary survey of the plants used against *Taenia cysticerci* in pigs in the study area showed that the breeders have knowledge of the plant species used for the treatment of cysticercosis. During this study, 14 plants from 12 families were inventoried as medicinal plants for porcine cysticercosis treatment. Different authors have already described the use of these plants in the treatment of animal helminth infections (Waller et al., 2001; Alawa et al., 2002; Dedehou et al., 2016; Saganuwan, 2017). The use of these plants may be explained from its components like tannins, saponins with anthelmintic activities (Sparg et al., 2004; Williams et al., 2014; Saganuwan, 2017). Some plant species had low FI values because some respondents did not know their use in the treatment of *T. solium* infections. This could be associated with the fact that most of the people acquired their knowledge orally from their elders, as reported by Mwale et al. (2005). It is important to document ethno-veterinary knowledge so that it will not be lost and to increase the use of common plants.

Various plant parts were used by breeders for animal care, ranging from leaves, flowers or inflorescences, stems, fruits, roots, to bark. Leaves were the most used part as reported by several authors (Prabhu et al., 2014; Vijayakumar et al., 2015; Parthiban et al., 2016). This could be explained by the fact that leaves are collected very easily than other parts like roots, flowers and fruits, etc. (Giday et al., 2009) and also because leaves are active in photosynthesis and production of metabolites (Ghorbani, 2005).

Conclusion

Pigs' farming is an important animal production in Burkina Faso. In the study area, pigs are kept in traditional breeding system which allows them to be easily exposed to porcine cysticercosis. In the study area, farmers had low knowledge on porcine cysticercosis and they adopt risky practices for porcine cysticercosis transmission. The study shows that different plants are used in the treatment of porcine cysticercosis. These results suggest

that control actions which focused on pigs deworming and people sensitization on *T. solium* cysticercosis are needed in the study area. Also, for future studies, it will be important to study the efficacy of this plant in the treatment of porcine cysticercosis.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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