RESEARCH ARTICLE

ENDO-, ECTO- AND HAEMO-PARASITES OF PIGS IN TANZANIA

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ABSTRACT

In recent years, pig husbandry has gained ground in comparison to production of ruminant animals. In Tanzania more than 90 per cent of the country's two million pigs are kept by small-scale farmers under both confined and free-roaming management systems as a sole enterprise in urban areas or as a component of a mixed crop-livestock system. Major constraints include poor management due to lack of knowledge by farmers, inadequate nutrition and limited veterinary services which result in heavy disease burdens. At least 10 species of endo-parasites have been identified in Tanzania's pig stock. Mange mites, ticks, lice and fleas infest a large proportion of pigs. Some five species of trypanosomes are blood parasites mainly in the northern part of the country. Constraints imposed by these parasites must be mitigated in order to improve the productivity of pigs in the country. This paper reviews the national literature on the subject.

Key words: Helminths, External parasites, Trypanosomes, Coccidia, Production systems

INTRODUCTION

In recent years, in some parts of sub-Saharan Africa there is evidence of a change in emphasis in the livestock sector away from ruminant production towards an increased importance of monogastric species. Estimates of cattle numbers increased twofold in the period 1961-2011 whereas pig numbers increased fivefold from 7.8 million to 35 million meaning that cattle numbers per person of the human population decreased but the number of pigs per person increased (FAOSTAT 2014). This situation results from a combination of factors including greater pressure on land suitable for grazing, competition for water, an increase in the incidence of ruminant diseases, urban development and the relative ease of keeping smaller animals with better feed conversion rates and faster growth. Increased human populations and rapid urbanization have propelled a greater

demand for pigs and pork and have encouraged greater investment in pig production. Smallholder pig production is currently synonymous with slow growth rates and low slaughter weights. In most low-income African countries the subsector is characterized by low investment and is often obstructed by inaccessibility to advice and guidance from specialist advisors, limited knowledge on pig husbandry and management, absence of organized breeding and marketing programmes, limited availability of veterinary pharmaceuticals, poor and unhygienic housing (Figure 1) and low quality feed (Lekule and Kyvsgaard 2003; Ngowi et al. 2004a; b; Kagira et al. 2010; Karimuribo et al. 2011; Komba et al. 2013; Mkupasi 2013; Wilson and Swai 2014).

Figure 1. Unhygienic and poorly constructed pig housing in a Dar es Salaam suburb

More than 90 per cent of the two million pigs in Tanzania are kept by small-scale farmers in low-input and low-output conditions under both confined and free-roaming management systems as a sole enterprise in urban areas or as a component of a mixed crop-livestock system. Some 20 per cent of all smallholder pigs are located in the southern Mbeya Region (URT 2012) which saw a large increase in the number of smallholder farmers after the introduction of Danish Landrace pigs in the 1970s.

Several earlier studies have been undertaken on various aspects of pig health and disease (Ngowi et al. 2004a; Braae et al. 2013; Komba et al. 2013; Wilson and Swai 2013). Such studies have, however, been restricted in geographical range (Kambarage 1991; Esrony et al. 1997; Kisinza et al. 2003; Ngowi et al 2004b; Mkupasi et al. 2010;

Hamill et al. 2013; Nonga and Paulo 2015). No historical study has systematically assessed the prevailing endo-, ecto- and haemo-parasites in pigs in Tanzania as a whole. This review aims to establish and map the distribution of these parasites that are of veterinary and public health importance in Tanzania.

ENDO-PARASITES

Helminths

Both intra- and extra-intestinal parasites occur in pigs in Tanzania. At least nine species of helminths have been identified with certainty (Table 1) as well as the coccidia-causing *Eimeria*.

Table 1. Helminth species identified in Tanzanian pigs

Species	Production system and location	References
Strongyles	Indoor/extensive; Arusha	Esrony et al. 1997; Nonga and Paulo 2015
Strongyloides ransomi	Indoor/extensive	Esrony et al. 1997; Mhoma et al. 2011; Mhoma et al. 2014
Oesophagastomum spp.	Indoor/extensive; Arusha, Morogoro	Esrony et al. 1997; Nonga and Paulo 2015;
Trichuris suis	Indoor/extensive; Arusha	Esrony et al. 1997; Mhoma et al. 2014; Nonga and Paulo 2015
Taenia solium	Indoor/extensive	Boa et al 1995; Ngowi et al. 2010;
Taenia hydatigena [a]	Indoor and extensive	Ngowi et al. 2004b
Echinococcus granulosus [b]		Ernest et al. 2009
Ascaris suum	Indoor/extensive	Esrony et al 1997; Mhoma et al. 2014;
Metastrongylus	Indoor/ extensive; Arusha	Esrony et al. 1997; Nonga and Paulo 2015;

Notes: a) also in sheep and goats
b) also in cattle

Intra-intestinal helminths

High recovery rates of 83 per cent of intestinal helminths were shown in an abattoir study in Arusha with Strongyles being predominant at rates of 52-75 per cent and most being recovered from the large intestine (Esrony et al. 1997; Nonga and Paulo 2015). High counts of helminth eggs (and coccidian oocysts) showed that pigs were severely affected and indicated the farm level endemicity of these parasites in Arusha city and Mbulu districts whence pigs are mainly sourced for slaughter. Similar results have been reported from other parts of Tanzania (Esrony et al. 1997; Mkupasi 2013). Surveys in Zimbabwe (Marufu et al. 2008), Mozambique (Matos et al. 2011), Nigeria (Sowemimo et al. 2012) and Kenya (Obonyo et al. 2012) showed variable but generally similar prevalences of gastrointestinal helminths.

Strongyloides ransomi was reported in pigs raised in two eco-climatic areas of Morogoro at a prevalence of 9 per cent (Esrony et al. 1997): this is considerably less than the 36.6 per cent in outdoor reared pigs in Busia District, Western Kenya (Kagira 2010). Differences in prevalence may be attributed to different climatic conditions in the study areas since the survival of *Strongyloides* larvae depends on the environmental temperature and moisture. The larvae of these species are susceptible to desiccation so dry areas provide an unfavourable environment for survival of *S. ransomi* larvae (Esrony et al. 1997; et al. 2008). Piglets are known to be more highly susceptible to *S. ransomi* than adult pigs (Nansen and Roepstorff 1999). In most

surveys, *Strongyloides* spp. were found to be more prevalent than other species (Esrony et al. 1997; Nonga and Paulo 2015). Differences in the prevalence of *Strongyloides* and other helminth species may be due to the variable climatic conditions, management systems, breeds and locally circulating parasites.

Species of *Oesophagostomum* have been identified as a common pig helminth in smallholder farms in Iringa and Morogoro regions (Esrony et al. 1997). The high prevalence of *Oesophagostomum* spp. may be attributed to its high egg excretion rate and the unhygienic conditions which are common in most of the pig production system in Tanzania (Karimuribo et al. 2011) and elsewhere in the East African region (Nissen et al. 2011).

Surveys in the Lake Zone in the vicinity of Mwanza showed a prevalence of *Trichuris suis* of about 5 per cent (Mhoma et al. 2014). This is comparable to prevalences recorded in outdoor reared pigs in the Northern and Southern Highlands of Tanzania (Esrony et al. 1997; Nonga and Paulo 2015), in Kenya (Kagira et al. 2010; 2012), in Ghana (Permin et al. 1999) and in Zimbabwe (Marufu et al. 2008) although a higher prevalence of 17 per cent has been reported in outdoor reared pigs in Uganda (Nissen et al. 2011). Variability in prevalences may be explained by the effect of environmental conditions on the development of *T. suis* eggs as these are susceptible to high mortality from dehydration and high temperatures (Pitman et al. 2010).

Extra-intestinal helminths

Extra-intestinal helminth diseases include porcine cysticercosis, hydatidosis and ascariosis (Ngowi et al. 2004a; Boa et al. 1995). Humans are the definitive hosts of *Taenia solium* in which the adult tapeworm occupies the small intestine. Pigs are the common intermediate hosts and harbour the larval stage of the parasite. The disease is prevalent in areas with traditional pig production systems, poor sanitation and inadequate or absence of meat inspection (Flisser et al. 2003; Sikasunge et al. 2007). *T. hydatigena* is also reported as an important parasite (Ngowi et al. 2004b). Porcine cysticercosis is endemic in many pig producing areas in Tanzania (Boa et al. 1995; Ngowi et al. 2004a; Boa 2005; Komba et al. 2013). It has been reported in Mbulu and Babati in the Northern Highlands since the mid 1980s at a prevalence ranging from 0.3 to 4.8 per cent (Nsengwa 1995; Nsengwa and Mbise, 1995; Ngowi et al. 2004a). In the Southern Highlands districts of Iringa Rural and Mbinga the prevalence ranged from 5.5 to 16.9 per cent (Komba et al. 2013). Slaughter slab surveys in Moshi, Arusha, and Mbulu indicated an overall prevalence of 13.3 per cent (Boa et al. 1995). In 21 villages in Mbulu District, whence most pigs slaughtered in Arusha are sourced indicated an overall prevalence of 17.4 per cent with rates in individual villages ranging from 3.2 to 46.7 per cent based on lingual examination of live pigs (Ngowi et al. 2004a). A recent study in Mbulu District established an incidence rate of 68.6 per 100 pig years in sentinel pigs (Ngowi et al. 2008). Slaughter slab surveys in Dar es Salaam revealed a prevalence of 6 per cent (Mkupasi et al. 2010). Porcine cysticercosis is reported as prevalent in Dodoma in central Tanzania and in Babati in the northern Manyara Region. Infection is higher in free ranging pigs, in communities that practice home slaughter and consume without proper meat inspection and in households that do not have latrines (Ngowi et al. 2004a).

Hydatidosis in livestock and humans arises from ingesting infective eggs of the cestode *Echinococcus granulosus*. Dogs are the primary definitive hosts for this parasite whereas livestock act as intermediate hosts and humans as aberrant intermediate hosts. An earlier report has described the endemic

occurrences of *E. granulosus* in dogs and livestock (Ernest et al. 2009). Abattoir records show that transmission of echinococcosis increases in areas where pigs are raised under a free range system (Ernest et al. 2009; Nonga and Paulo 2015). This system is common in the Northern Highlands in Babati, Mbulu and Karatu Districts – where prevalence is reported as 4.3 per cent (Ngowi et al. 2004b) -- and in Mbeya, Mbozi, Iringa and Sumbawanga Districts in the Southern Highlands but pigs imported from Singida, Mbeya, Rukwa, Morogoro and Dodoma Regions slaughtered in Dar es Salaam also harbour the parasite (Mkupasi et al. 2010). The condition thus appears to be country wide but the role played by the parasite has not been extensively investigated in the country.

Ascariosis caused by *Ascaris suum* is among the leading causes of liver condemnation during post-mortem meat inspection. A prevalence of 12 per cent of ascariosis in pigs in Morogoro Region by coprological examination has been reported (Esrony et al. 1997). A prevalence of 44.3 per cent of liver milk spots in pigs slaughtered in northern Tanzania has been reported (Ngowi et al. 2004b). A prevalence of 8 per cent infection at Dar es Salaam slaughter points has been recorded (Mkupasi et al. 2010). A very high prevalence of 37 per cent has been noted at slaughter slabs in Arusha, Region (Nonga and Paulo 2015). High infection rates by *A. suum* are correlated with wet conditions, temperature and unhygienic environments (Kagira et al. 2010; Obonyo et al. 2012). Formerly considered as a parasite of pigs there is growing concern about cross-infection of *A. suum* to humans (Nejsum et al. 2005). The parasite is prevalent in pigs in Tanzania, causes heavy economic losses and has possible public health implications (Kakihara et al. 2004).

Lung worms of the genus *Metastrongylus* were detected in slaughtered pigs in northern Tanzania at a low prevalence (Nonga and Paulo 2015). The parasite is also recorded, also at a low prevalence, from the Morogoro area (Esrony et al. 1997). Probable reasons for the apparent low prevalence relate to the low fecundity of the parasite and the difficulties associated with finding eggs in faeces when using the regular detection methods (Nansen and Roepstorff 1999; Stewart and Hoyt 2006; Kagira et al. 2010).

Parasites other than helminths

Examination of intestinal contents of pigs slaughtered in Northern Tanzania showed oocysts of *Eimeria* species at a prevalence of 19 per cent (Nonga and Paulo 2015). Transmission of coccidiosis is aided by warm, wet environmental conditions. Stress from weaning in piglets often induces outbreaks of coccidiosis. Clinical signs include diarrhoea (sometimes containing blood or mucous), dehydration, fever, weight loss, inappetance anaemia and death.

ECTO-PARASITES

Mange mites

Sarcoptic mange caused by *Sarcoptes scabiei* var. *suis* and demodectic mange due to *Demodex phylloides* are the principal mange problems in pigs. These mites of the subclass Acari are not visible to the naked eye. In pigs, the main sites of infestation are around the eyes, the outer or inner surface of the ear or along the shoulder and the top of the neck. *S. scabiei* var. *suis* is economically the most important mite of swine as it can significantly reduce the efficiency of feed conversion and the rate of weight gain (Davies 1995). Sarcoptic mange is inimical to welfare especially through the discomfort it causes which pigs attempt to ameliorate by scratching and rubbing of the affected parts. Both *S. scabiei* and *D. phylloides* have been reported in pigs in Tanzania (Braae et al. 2013; Mhoma et al. 2014; Kabululu et al. 2015). Some 88 per cent of pigs examined in towns in six Tanzania regions were

infested with *S. scabiei* and 95 per cent of those infested pigs had the hypersensitive form of mange (Kambarage 1992). An epidemiological survey of sarcoptic mange in 32 herds comprising 2021 pigs conducted in three representative climatic zones revealed disease presence in 91 per cent of herds in all zones at varying prevalences (Kambarage et al. 1990). The prevalence of sarcoptic mange in urban and peri-urban areas of cities was 21.9 per cent (Braae 2011). Treating infected pigs subcutaneously with a single dose of Ivermectin at 200 ug/kg body weight eliminates mites and prevents transmission of mange from sows to their offspring (Firkins et al. 2001). Doramectin has been shown to be more effective than ivermectin in experimental infestations of *S. scabiei* var. *suis* although both drugs are used to control ecto- and endo-parasites in pigs (Logan et al. 1996; Arends et al. 1999). Other drugs used to treat sarcoptic mange that have resulted in complete recovery include 20 per cent phosmet at a dose rate of 20 mg/kg body weight and 2 per cent trichlorphon (Kambarage 1991).

Ticks

At least five species of ticks have been identified infesting pigs in Tanzania (Kisinza et al. 2003; Braae 2011; Braae et al. 2013; Kabululu et al 2015). Four of these species – *Amblyomma variegatum*, *Rhipicephalus appendiculatus*, *Boophilus decolaratus* and *Haemaphysalis* sp. – are hard ticks and one – *Ornithodoros moubata* – is a soft tick.

Studies in Mbeya Region reported 50 per cent prevalence of hard ticks in free range pigs (Braae 2011; Braae et al. 2013; Kabululu et al 2015). Keeping pigs in a free range system and contact with neighbouring pigs are main risk factors for the presence of ticks. Keeping pigs in confinement could be a highly effective tool for preventing infection by hard ticks. *Ornithodoros moubata* is considered important in Eastern and Southern Africa in the transmission of African swine fever (ASF) (Plowright et al. 1969; Kleiboeker and Scoles, 2001). *O. moubata* has the capacity to replicate and maintain the virus for many years while passing it from tick to tick during mating and developmental stages. Other tick species are of less significance to the pig production system and they can be easily managed by removing them manually.

Lice

The hog louse *Haematopinus suis* is a sucking louse found almost solely on the skin surface of swine: it takes several blood meals a day from its host. It is recorded in pig herds in Tanzania in both confined and free range systems with a prevalence of 20 per cent in the former and 63 per cent in the latter one (Braae 2011; Kabululu et al. 2015). Risk factors for lice infestation in Tanzania are the presence of neighbouring pigs.

Fleas

Fleas are widely distributed on pigs in Tanzania but are not of major importance. The four species identified are *Tunga penetrans*, *Echidnophaga gallinacea*, *Ctenocephalides canis* and *Ctenocephalides felis* (Kilonzo et al. 2001; Braae 2011; Braae et al. 2013; Kabululu et al. 2015). Infestation rates in confined systems are reported as 5 per cent and as 13 per cent in free ranging systems (Braae et al. 2013; Kabululu et al. 2015). As is evident from the specific names of the fleas identified the main risk factor is contact with companion animals and poultry.

HAEMO-PARASITES

Haemo-parasites of pigs in Tanzania appear to be limited to species of *Trypanosoma* which have so far only been identified in the northern part of the country (Hamill et al. 2013). The species so far identified are

Trypanosoma simiae, *T. vivax*, *T. congolense*, *T. godfreyi*, *T. brucei* s. l. and *T. brucei rhodesiense* (Hamill et al. 2013). The main pathogen in pigs in Tanzania appears to be *T. simiae* which is almost invariably a fatal disease in this animal. Pigs act mainly as a reservoir of trypanosomosis for the other trypanosome species. *T. brucei rhodesiense* is a potential zoonose.

CONCLUSION

Parasitic infections are a major constraint to improved livestock productivity. Tanzania's livestock are host to a plethora of parasites and their attendant diseases. The distribution and persistence of these organisms in Tanzania has been shown to be due to a combination of factors. In addition to the presence of a parasite itself poor husbandry practices contribute to the problem and these are compounded by an absence of extension services and low levels of education of most producers. Nutrition is usually inadequate. Veterinary services are limited and in general are directed to ruminant animals. Prevalent rates of infection or infestation appear not to be affected by the various categories of age groups, management systems and animal sex. It seems, therefore, that the predisposition to parasite attack is uniform regardless of these factors (MLFD 2010; Mkupasi 2013).

Farmers should be educated and encouraged to improve general management and husbandry practices including regular drenching against worms. The gender of managers and the level of education are important considerations in future programmes designed to improve pig productivity(Wabacha et al. 2004a; 2004b).

Conflict of interest

The authors declare there are no conflicts of interest.

Authors' contributions

All authors have worked in the field in Tanzania. The concept of the paper was developed by all authors working together and all contributed to the review of the literature. Emmanuel Swai, assisted by Elpidius Rukambile and Augustino Chengula, worked collaboratively on a first draft of the paper. Trevor Wilson edited and remodelled the first draft and corrected the English grammar. All authors have agreed the content and form of this version of the paper.

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