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Management of parasitic infections in pigs in the Brazilian Agreste

Manejo de infecções parasitárias em suínos no Agreste brasileiro

Manejo de infecciones parasitarias en cerdos en el Agreste brasileño

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RESUMO

Introdução: No Nordeste brasileiro, a criação de suínos é desenvolvida com dificuldades, devido às condições climáticas locais, gastos com alimentação e infecções parasitárias.
Objetivo: Estimar a prevalência de infecções enteroparasitárias em granjas de suínos no estado de Sergipe e avaliar a influência de fatores relacionados aos sistemas de produção na infecção parasitária.
Métodos: Foram analisadas amostras fecais de 588 suínos e avaliadas as condições de manejo das granjas entre setembro de 2013 e novembro de 2014.
Resultados: Dos suínos analisados, 47,62% apresentavam alguma espécie de enteroparasita; os protozoários mais prevalentes foram *Balantidium coli* (26,19%) e *Eimeria* sp. (15,48%) e dentre os helmintos, Strongyloidea (14,46%) e *Ascaris suum* (13,95%). A prevalência de enteroparasitas em suínos sergipanos é consequência de fatores associados ao manejo das granjas: falta de assistência técnica, administração de antiparasitários e tipo de ração.
Conclusão: Os resultados obtidos contribuem para a construção do quadro epidemiológico das enteroparasitas em suínos criados no estado de Sergipe, bem como auxiliam no seu controle e prevenção.
Palavras-chave: parasitas intestinais; suinocultura; manejo; epidemiologia; agreste

ABSTRACT

Introduction: In northeastern Brazil, pig farming is difficult due to local climatic conditions, food costs and parasitic infections.
Objective: to estimate the prevalence of enteroparasitic infections in pig farms in the state of Sergipe and to evaluate the influence of factors related to production systems on parasitic infection.
Methods: Faecal samples from 588 pigs were analysed, and the management conditions of the farms between September 2013 and November 2014 were evaluated.
Results: Of the analysed pigs, 47.62% had some enteroparasite species; the most prevalent protozoa were *Balantidium coli* (26.19%) and *Eimeria* sp. (15.48%), and among the helminths, Strongyloidea (14.46%) and *Ascaris suum* (13.95%) were the most prevalent. The prevalence of enteroparasites in Sergipe pigs is a consequence of factors associated with the management of farms: lack of technical assistance, administration of antiparasitic agents and type of feed.
Conclusion: The results obtained contribute to the construction of the epidemiological picture of enteroparasites in pigs raised in the state of Sergipe, as well as help in its control and prevention.
Keywords: intestinal parasites; pig farming; management; epidemiology; agreste

RESUMEN

Introducción: En el Nordeste brasileño, la cría de cerdos es difícil debido a las condiciones climáticas locales, costos de alimentos e infecciones parasitarias.
Objetivo: Estimar la prevalencia de infecciones enteroparasitarias en granjas porcinas del

estado de Sergipe y evaluar la influencia de factores relacionados con los sistemas de producción sobre la infección parasitaria.
Métodos: Se analizaron muestras fecales de 588 cerdos y se evaluaron las condiciones de manejo de la granja entre septiembre de 2013 y noviembre de 2014.
Resultados: De los cerdos analizados, el 47,62% presentó algún tipo de enteroparásito; los protozoos más prevalentes fueron *Balantidium coli* (26,19%) y *Eimeria* sp. (15,48%) y entre los helmintos, Strongyloidea (14,46%) y *Ascaris suum* (13,95%). La prevalencia de enteroparásitos en cerdos en Sergipe es consecuencia de factores asociados al manejo de la granja: falta de asistencia técnica, administración de antiparasitarios y tipo de alimento.
Conclusión: Los resultados obtenidos contribuyen para la construcción del cuadro epidemiológico de los enteroparásitos en cerdos criados en el estado de Sergipe, además de ayudar en su control y prevención.
Palabras clave: parásitos intestinales; cría de cerdos; gestión; epidemiología; agreste

INTRODUCTION

Brazil is the fourth largest producer and exporter and the sixth largest consumer of pork worldwide, with an estimated consumption of 18 kg per capita. In 2022, 4,983 thousand tons of pork were produced in the country, of which 77.5% was destined for the domestic market and 22.5% for the foreign market, equivalent to US$ 2,573 million in revenue, with China, Hong Kong and Philippines as the main destinations of Brazilian production (ABPA, 2023). The gross domestic product of this production chain is R$ 62 billion, and the southern region of Brazil accounts for 69.3% of the slaughter of pigs, followed by the southeast (16.27%), central-west (14.3%), north (0.093%), and northeast (0.04%) regions. In 2015, this activity generated 126 thousand direct jobs (creation and slaughter) and more than 900 thousand indirect jobs (IBGE, 2018).

Brazilian pig farming has different production models based on the region of the country; in the southern region, there is a predominance of cooperatives and integrated producers, while in the southeast region, there is a predominance of independent farms with up to 780 sows. In the midwest region, the largest producers are directly linked to agroindustries, with up to 1000 sows, whereas in the north and northeast regions, producers are independent, with smaller-scale farms with up to 200 sows (ABCS, 2016).

The northeast region has a herd of approximately 5 to 6 million heads, distributed in 8 states, i.e., Bahia, Ceará, Maranhão, Alagoas, Sergipe, Pernambuco, Rio Grande do Norte and Piauí, in descending order of number of sows (ABCS, 2016).

According to the Municipal Livestock Profile Survey conducted by the Brazilian Institute of Geography and Statistics (IBGE, 2023), the state of Sergipe houses approximately 121,058 animals distributed throughout the state. Production is mainly concentrated in the Agreste and semiarid regions and characterized by low technology farms, with little or no technical assistance and as an alternative for family income (BARBOZA, 2017).

Parasitic infections interfere with the development of pig production. The high loads of gastrointestinal parasites cause the malabsorption of food due to lesions in the mucosa, allowing the formation of gastric wounds, with the appearance of bulges and small haemorrhages, until severe gastritis compromises the sale of and profits from the viscera by slaughterhouses (JESUS; MÜLLER, 2000). Coupled with this, there is an increase in morbidity/mortality and economic loss due to veterinary treatment and service costs (ANTUNES et al., 2011).

The main gastrointestinal parasites that affect pigs are the nematodes *Ascaris suum*, *Globocephalus urosubulatus*, *Oesophagostomum dentatum*, *Trichuris suis*, *Metastrongylus* sp., *Stephanurus dentatus* and *Strongyloides ransomi* (D'ALENCAR et al., 2006; GREVE, 2012) and protozoa of the genera *Eimeria*, *Cystoisospora*, *Cryptosporidium*, *Giardia*, *Balantidium* and *Entamoeba*. These parasites negatively influence nutrient absorption due to oesophageal disorders and intestinal and hepatic lesions (PEDERSEN et al., 2002).

The presence of intestinal parasites is the second major reason for discarding this organ after slaughter, as such parasites prevent the use of the intestine as a wrapper in the production of sausages (FAUSTO et al., 2015; PEREIRA et al., 2018). In addition to the economic impact, some parasites can potentially cause infections in humans, and pigs can disseminate these agents to both direct workers and the population, mainly through the inadequate management of organic waste generated in the area during animal production (LINDSAY et al., 2012; CARREIRO et al., 2016).

Considering the above, the objective of this study was to evaluate the influence of pig production management practices on intestinal parasitic infections in farms located in the rural region of the state of Sergipe.

MATERIALS AND METHODS

The study was conducted in 20 pig farms located in municipalities of the state of Sergipe (Itabaiana, Campo do Brito, Macambira, São Domingos and São Miguel do Aleixo – Figure 1), from September 2013 to November 2014, both in farms associated with COOPERGIPE (Cooperative of Pig Producers of Milk and Derivatives of Sergipe – 55.0% of the farms studied) and in non-associated farms (45.0% of the farms studied). The Agreste region of Sergipe has the highest concentration of pig production in the state, with a current herd of approximately 18,800 heads (IBGE, 2023).

The minimum sample size was determined using the calculation described by Barbetta (2010), considering the estimated swine population in the region for 2012 (11388 heads according to the IBGE Livestock survey https://cidades.ibge.gov.br/), with a maximum margin of error of 4% and a confidence interval of 95%. A total of 588 faecal samples were collected from pigs during 3 different production stages (AMARAL et al., 2006), i.e., 133 animals in the nursery phase, 183 in the growth phase, and 272 in the reproduction phase.

During the visits for the collection of faecal samples, a specific protocol was followed, recording information related to the type of feed provided to the animals and the frequency of food supply, the frequency of the administration of antiparasitic drugs to the herd, the type of farm production, and the presence of technical assistance.

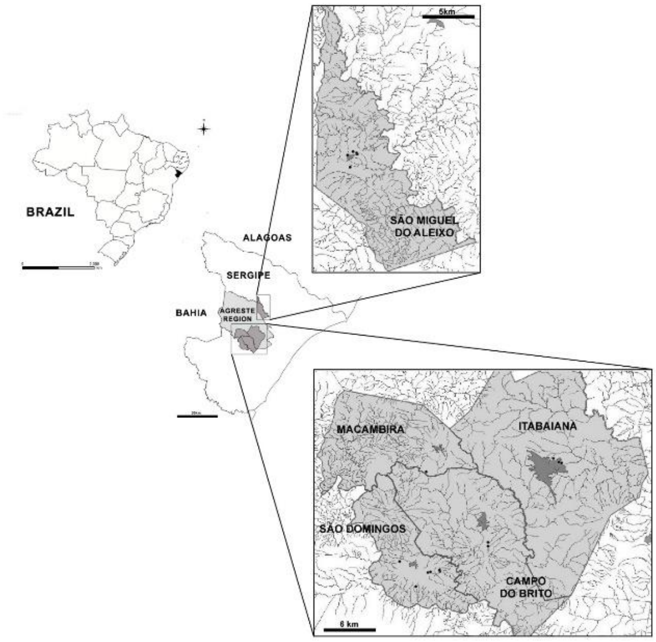


Figure 1: Location of the municipalities and the respective properties studied (black dots) in the rural region of Sergipe.

Faeces was collected directly from the rectal ampulla, placed in collection flasks, and transported in a refrigerated cooler to the Laboratory of Infectious and Parasitic Diseases, Institute of Technology and Research, Aracaju, SE. Coparasitological research was performed using spontaneous sedimentation and sodium chloride flotation methods. For the quantitative analysis, the number of eggs per gram of faeces (EPG) and the number of oocysts per gram of faeces (OoPG) were calculated using the McMaster technique (GORDON; WHITLOCK, 1939). The parasites (cysts, oocysts, eggs and larvae) were identified in accordance with Roepstorff and Nansen (1998) and Bowman et al. (2006).

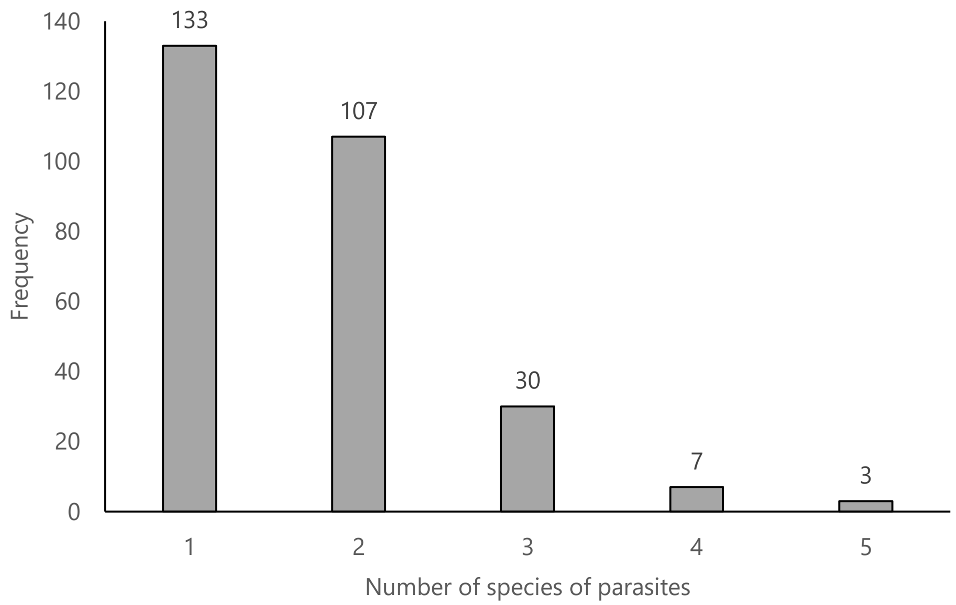
The management variables "type and frequency of feeding" and "presence of technical assistance" were assessed using the odds ratio (OR) test, and "frequency of administration of antiparasitic drugs" was assessed using the G test to evaluate the influence of this variable on the percentage of infection (prevalence) of protozoa and helminths among pigs. The differences in the means EPG and mean OoPG among the production stages were analysed using the ANOVA with Duncan's post hoc test, and the chi-squared test was used to verify the differences between the prevalence of protozoa, helminth and enteroparasites infections in general. For blank cells (zero) in the contingency tables, the algorithm described by Herrero et al. (1999) with adjusted degrees of freedom was used to estimate the expected value while maintaining the original proportion and dimensionality of the data. When necessary, the data were subjected to logarithmic transformation [log (x+1)], and all tests were applied using BioEstat v. 5.3 (AYRES et al., 2007) and Statistca v. 7.1 (StatSoft Inc., Tulsa), considering a significance level of 5%.

The study was approved by the Ethics Committee on Animal Use of the University of Tiradentes, SE (register number 040613; June 27, 2013).

RESULTS AND DISCUSSION

Among 20 farms, 588 faecal samples were collected and analysed, and 47.61% (280/588) were positive for some type of parasite, among which 47.50% were positive for only one type of parasite (monoparasitism) and 52.50% were positive for multiple types of parasites (polyparasitism) (Figure 2). The prevalence of enteroparasites in pigs in the rural region of Sergipe was high, probably due to the low annual frequency of the administration of antiparasitic drugs to pigs, i.e., not complying with the four or more applications per year recommended by COOPERGIPE (José Evairton Andrade Brito Junior, president, personal communication).

Figure 2: Parasitic infections by number of species per infection in pigs in the state of Sergipe, Brazil



Several studies have been conducted in Brazil to evaluate the prevalence of gastrointestinal parasites in pigs: D'Alencar et al. (2006) in Pernambuco (2.44%); Nishi et al. (2000) in the states of Minas Gerais (38.6%) and São Paulo (39.7%); Sangioni et al. (2017) in Rio Grande do Sul (60.9%); Silva et al. (2015) in Maranhão (72%); Carreiro et al. (2016) in Rio de Janeiro (72.7%); Brito et al. (2012) in Sergipe (90%); Loddi et al. (2015) in Paraná (91.89%); and Aguiar (2009) in the Federal District (96.14%).

The variations in the results are directly related to the health of the herd and/or hygienic-sanitary conditions of their habitats.

The mean OoPG and mean EPG in the pigs studied were 699.83 (±4,962.66) oocysts/g_{faeces} and 562.93 (±2,618.58) eggs/g_{faeces}, respectively. Similar to that reported by D'Alencar et al. (2006), a statistically significant difference was observed in the oocyst count based on the production phase (Table 1). The highest OoPG and OPG values were found in pigs that were in the nursery phase, at which time these animals were weaning (stressor) and more susceptible to infections, both due to decreased intestinal transit and because the immune system was still developing.

Table 1: Mean eggs (EPG) and oocysts (OoPG) per gram of faeces for pigs in different stages of development on farms in the state of Sergipe, Brazil.

	OPG sd	p	OoPG sd	p
Nursery	137,67[a] ±326.96	0.0798	1.362,18[a] ±8069.18	<0.0001
Growth	672,68[a] ±2.960,64		351,53[b] ±2.870,42	
Reproductive	697,02[a] ±2.966,27		610,29[c] ±3.973,88	

sd - standard deviation; means with the same letter are not significantly different
ANOVA with Duncan's *post hoc* test

Of the faecal samples analysed, 64 (10.88%) contained helminths only, 107 (18.19%) contained protozoa only, and 109 (18.53%) contained both protozoa and helminths. Among the protozoa, *Balantidium coli* (26.19%) and *Eimeria* sp. (15.48%) were predominant, with a lower occurrence of *Cystoisospora suis* (2.89%) (Table 2). Aguiar (2009) found a higher prevalence of mixed infections (75%) in family farms and low-tech farms, and of those that were monoparasitized, 88.89% were due to protozoa, i.e., 62.96% due to *Balantidium coli* and 25.93% due to coccidia. Carreiro et al. (2016) reported that 75% of the samples evaluated in a farm with a semi-intensive rearing system were positive for polyparasitism.

The occurrence of polyparasitism can be facilitated when animals are not provided an environment that ensures comfort, with sufficient quality and quantity of food; this lack of adequate management contributes to the increased stress of animals and consequently to a reduction in immunity. Infectious diseases can act synergistically with the occurrence of other types of disease (CARREIRO et al. 2016).

Among helminths, Strongyloidea was the most prevalent, followed by *Ascaris suum*, *Strongyloides ransomi*, *Metastrongylus* sp., *Trichuris suis* and *Oesophagostomum sp*. (Table 2). Loddi et al. (2015) found a higher prevalence of general gastrointestinal nematodes (91.89%), followed by *Strongyloides* sp. (29.73%) and *Ascaris* sp. (18.92%), on traditional and extensive farms in southern Paraná, despite those farms being intensive and technified. The prevalence of *Ascaris suum* found in this study was similar to that recorded by Loddi et al. (2015), a finding that may suggest the existence of anthelmintic resistance or a deficiency in the hygiene of the facilities, i.e., eggs persist in the environment, in the embryonic form, causing reinfections (NISHI et al., 2000; SANCHEZ-VAZQUEZ et al., 2012).

In Poland, the fourth largest producer of pork in the European Union, a high prevalence of infection by *Oesophagostomum* sp. was reported; infections by coccidia, *Ascaris suum*, *Trichuris suis* and *Strongyloides* sp. were lower (KOCHANOWSKI et al. 2017).

A previous study by Brito et al. (2012), in the municipality of Simão Dias, in the region of Zona da Mata bordering the Agreste region of Sergipe, showed positivity in 90% of the faecal samples evaluated, with eggs of *Ascaris suum* (16%), *Trichuris suis* (8%), and the superfamily Strongyloidea (34%) being identified; among the protozoa, *Balantidium coli* in its cystic and trophozoite forms were identified in approximately 80% of the samples. These percentages are higher than those found in the present study because the properties evaluated by Brito et al. (op. cit) were primarily domestic with deficiencies in pen hygiene and in the water supply. In Colombia, Pinilla et al. (2020) report that 91% of pigs raised in backyards were parasitized, and this high prevalence could be controlled by improving management practices and agricultural facilities.

Table 2: Prevalence of enteroparasitic infections in pigs raised in the state of Sergipe from September 2013 to November 2014.

	Ascaris suum	Strongyloidea	*Strongyloides ransomi*	*Metastrongylus* sp.	*Trichuris suis*	*Oesophagostomum* sp.	*Balantidium coli*	*Eimeria* sp.	*Cystoisospora* sp.
Nursery	18.05%	9.02%	- -	2.26%	2.26%	- -	27.07%	15.79%	1.50%
Growth	13.66%	7.65%	1.64%	1.64%	3.28%	0.55%	21.31%	12.02%	1.09%
Reproductive	12.13%	21.69%	7.72%	4.04%	- -	- -	29.04%	17.65%	4.78%
p	0.2698†	<0.0001†	<0.0001†	0.2777*	0.0030*	0.3106*	0.1780†	0.2646†	0.0342*
General	13.95%	14.46%	4.08%	2.89%	1.53%	0,17%	26.19%	15.48%	2.89%

† Chi square test

*G test

In a coproparasitological study of pigs raised in a confined system in the state of Santa Catarina, Hoff et al. (2005) found prevalence rates different from those obtained in the present study: 21.5% for Strongyloidea-type eggs, 2.0% for *Ascaris suum* and 0.5% for *Trichuris suis*. This low prevalence of ascarids in farms in southern Brazil may be related to animal management, which includes the previous disinfection of pens and one-week sanitary vacancies, which interrupt the transmission cycle of several parasites.

The production phase with the highest number of parasitized animals was reproduction (52.86%; 148/280), followed by nursery and growth (23.57% infection; 66/280 in both). Such susceptibility to parasitic infections may be related to the phase of the life cycle of the studied females (peripartum or postpartum), who may have been physiologically weakened due to giving birth or lactating. Another factor that contributes to inefficient strategic control of enteroparasitic infections is the “spring rise” phenomenon or the breakdown of immunity in the peripartum period (BARGER 1993). In addition, breeders remain on farms for up to 5 years in locations with a constant presence of water that keeps the soil oversaturated, which favours not only the maintenance of parasites in the environment but also the reinfection of animals (CARREIRO et al. 2016).

Pradella et al. (2020) suggest that the infection occurs during the lactation phase, in which piglets become infected when they ingest helminth eggs or oocysts while nursing in the mammary glands of infected sows, which are contaminated with fecal material (fecal-oral transmission).

In Poland, the highest prevalence of infections by coccidia was found in suckling piglets (14.2%), followed by sows (6%), finishing piglets (3.7%) and weaned piglets (3.5%); the prevalence in infants was significantly different from that in pigs of other ages (KOCHANOWSKI et al., 2017).

In the present study, 78.23% of the farms evaluated used balanced feed at different stages of development, while 21.77% used leftover food and agricultural waste (husks and bagasse). The animals fed leftovers and agricultural waste had a 3.5 times higher likelihood of being infected by protozoa than did those fed only feed (Table 3). Because of the presence of a dairy basin in the state of Sergipe, to reduce production costs, some breeders use leftover food and/or by-products from milk processing (BARBOZA, 2017). This practice, however, can lead to parasitic infections because food debris can carry eggs and/or oocysts of direct-cycle parasites, among other infectious agents. Current legislation stipulates that the material used in pig feed must undergo heat treatment before being supplied to animals (BRASIL, 2004).

Table 3: Management characteristics used by pig farmers in the state of Sergipe and the occurrence of enteroparasites (protozoa and helminths) in pigs from September 2013 to November 2014.

Protozoa	Positive	Negative	
Food			p < 0,001†
Waste	78	50	OR = 3.53
Feed	138	312	2.35 ≤ μ ≤ 5.30
Feeding Frequency			p < 0,001†
2 times per day	58	59	OR = 2.32
Ad lib	158	373	1.54 ≤ μ ≤ 3.49
Technical Assistance			p < 0,001†
No	48	33	OR = 2.94
Yes	168	339	1.82 ≤ μ ≤ 4.74
Frequency of Antiparasitic Drug Application			
1 time per year	34	30	p < 0,001*
2 times per year	107	119	G = 81.68
3 times per year	75	155	
More than 3 times per year	0	68	
Helminths	Positive	Negative	
Food			p = 0.8538†
Waste	39	89	OR = 1.07
Feed	134	326	0.69 ≤ μ ≤ 1.63
Feeding Frequency			p = 0.0128†
2 times per day	58	59	OR = 0.52
Ad lib	158	373	0.32 ≤ μ ≤ 0.86
Technical Assistance			p = 0.0287†
No	48	33	OR = 0,050
Yes	168	339	0.28 ≤ μ ≤ 0.91
Frequency of Antiparasitic Drug Application			
1 time per year	34	30	p < 0,001*
2 times per year	107	119	G = 49.38
3 times per year	75	155	
More than 3 times per year	0	68	

†*Odds Ratio*
*G test

Kagira (2008) reports a significantly higher prevalence of helminths in farms that provide noncommercial feed to animals. In the present study, approximately 60.9% of the farms that used "waste" feeds presented animals positive for parasitic infection.

The factors that were relevant in the occurrence of enteroparasites in pig farms in Sergipe were antiparasitic periodicity/year, technical assistance and feeding, with the amount of annual antiparasitic drug the factor of greatest influence in the appearance of enteroparasites. Among the properties that applied antiparasitic drugs more than 3 times a year, there were significant differences in the type of parasite (helminths and protozoa) for all production phases evaluated (Table 4). D'Alencar et al. (2011) assessed pig enteroparasites and hygienic-sanitary management conditions in subsistence and technified farms in the Pernambuco Forest Zone, obtaining lower percentages of parasite occurrence in farms that used antiparasitic drugs; however, the frequency of application of medications was not specified.

In traditional Brazilian pig farming regions, technological innovations have been implemented since the end of the twentieth century, leading to increased profits from animal rearing and the consequent increase in production. The main technological innovations are related to nutritional input, with the supply of corn, soybean, and wheat in the feed for pigs, in addition to improvements in management techniques, medications and genetics (SILVA FILHA, 2008).

However, the scenario described by Silva Filha (2008) is not representative of most of the pig farms in the state of Sergipe, in which 21.77% of the farms studied still provided waste for food and 13.78% of the owners did not rely on technical assistance. Animals at farms without technical assistance had a 2.9 times higher likelihood of becoming infected with protozoa than did animals at farms that utilized technical assistance (Table 3).

The pigs at farms associated with COOPERGIPE were bred after genetic improvements and were vaccinated against leptospirosis, pneumonia, parvoviruses, mycoplasma, rhinitis, circoviruses and gastroenteritis. Associations and/or cooperatives facilitate the granting of rural credits to farmers, improvements in production rates, the continuous exchange of information/experiences among pig farmers and technical assistance, decreasing the rates of ectoparasitic infection.

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According to Pereira et al. (2018), ascaridiosis and oesophagostomy were the major causes of intestinal compromise in the inspection line of a pig slaughterhouse monitored by the Federal Inspection Service. These conditions cause economic losses because the intestines cannot be used as natural casings for the production of sausage. Severe infection by *Ascaris suum* can also cause the liver to be discarded; the passage, in this organ, of the larval phase of this worm causes lesions (FAUSTO et al., 2015).

It is important to emphasize the zoonotic potential of some parasites found in this study, for example *Balantidium coli* and *Ascaris suum,* which can cause severe dysentery in humans, not only in workers who come into direct contact with animals but also in individuals who live in areas in close proximity to pig farms. The inadequate management of organic waste generated by pig production and the use of pig manure for fertilizer, especially for plants for human consumption, pose risks with regard to spreading parasites to humans (NEJSUM et al., 2012; BARBOSA, 2015).

Table 4: Management characteristics of pig farms in the state of Sergipe and the occurrence of enteroparasites (protozoa and helminths) for pigs in different life stages from September 2013 to November 2014.

Protozoa	Nursey			Growth			Reproductive		
	P	N		P	N		P	N	
Food			p = 0.0001†			p = 0.0002†			p = 0.0005†
Waste	22	9	OR = 5.59	15	15	OR = 3.14	41	26	OR = 2.82
Feed	31	71	2.32 ≤ μ ≤ 13.54	37	116	1.40 ≤ μ ≤ 7.02	70	125	1.59 ≤ μ ≤ 4.98
Feeding Frequency			p = 0.0695†			p = 0.4874†			p = 0.0302†
2 times per day	22	20	OR = 2,13	6	14	OR = 1.65	30	25	OR = 2.01
Ad lib	31	60	1.01 ≤ μ ≤ 4.48	46	177	0.60 ≤ μ ≤ 4.53	81	136	1.11 ≤ μ ≤ 3,66
Technical Assistance			p = 0.0024†			p = 0.3480†			p = 0.0136†
No	22	13	OR = 3,66	6	8	OR = 2.01	20	12	OR = 2.73
Yes	31	67	1.63 ≤ μ ≤ 8.19	46	123	0.66 ≤ μ ≤ 6.09	91	149	1.27 ≤ μ ≤ 5.85
Frequency of Antiparasitic Drug Application			p < 0.0001▲			p < 0.0001▲			p < 0.0001▲
1 time per year	17	5	G = 29.31	4	15	G = 31.98	13	10	G = 30.88
2 times per year	14	25		29	33		64	61	
3 times per year	22	34		19	50		34	71	
More than 3 times per year	0	16		0	33		0	19	

Helminths	Nursery			Growth			Reproductive		
	P	N		P	N		P	N	
Food			p = 0.9001*			p = 0.8401†			p = 0.0217†
Waste	37	65		30	123	OR = 1.03	67	138	OR = 1.95
Feed	0 (18)	31		6	24	0.38 ≤ μ ≤ 2.73	33	34	1.14 ≤ μ ≤ 3.50
Feeding Frequency			p = 0.8908*			p = 0.1468†			p = 0.7061†
2 times per day	0 (29)	42		1	19	OR = 0.19	22	33	OR = 1.18
Ad lib	37	54		35	128	0,02 ≤ μ ≤ 1.49	78	138	0.64 ≤ μ ≤ 2.16
Technical Assistance			p = 0.8875*			p = 0.3803†			p = 0.4982†
No	0 (21)	35		1	13	OR = 0.29	14	18	OR = 1.39
Yes	37	61		35	134	0.04 ≤ μ ≤ 2.33	86	154	0.66 ≤ μ ≤ 2.94
Frequency of Antiparasitic Drug Application			p < 0.0001▲			p < 0.0001▲			p = 0.0014▲
1 time per year	0	22	G = 46.79	0	19	G = 27.42	12	11	G = 15.48
2 times per year	6	33		17	45		53	72	
3 times per year	31	25		19	50		34	71	
More than 3 times per year	0	16		0	33		1	18	

P - Positive; N – Negative
*Chi square test - applied the algorithm described by Herrero et al. (1999)
†*Odds Ratio*
▲G test

CONCLUSÃO

A Given the results, it is necessary to implement protocols for cleaning and disinfecting facilities and for perform periodic coprological examinations of animals to monitor for infections and verify the efficacy of prevention and control measures. In addition, health education activities should be promoted for workers to reduce opportunities for acquiring parasitic infections from pigs; routine coprological tests should be provided to farm workers to monitor worker health.

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