

Indonesian Journal of Tropical and Infectious Disease

Vol. 8 No. 1 January-April 2020

Research Article

A Survey for Zoonotic and Other Gastrointestinal Parasites in Pig in Bali Province, Indonesia

Ni Komang Aprilina Widisuputri¹, Lucia Tri Suwanti^{2,3,a}, Hani Plumeriastuti⁴

¹Postgraduate Student, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia.

²Department of Veterinary Parasitology, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia.

³Institute of Tropical Diseases, Universitas Airlangga, Surabaya, East Java, Indonesia.

⁴Department of Veterinary Pathology, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia.

^aCorresponding author: tswant@gmail.com; phone number: +6281226094872

Received: 8th November 2018; Revised: 21st December 2018; Accepted: 25th February 2019

ABSTRACT

Pigs have potentially to transmit zoonotic gastrointestinal parasite disease both caused by protozoa and worm. The aim of this study was to identify gastrointestinal parasites that were potentially zoonotic in pigs in the province of Bali. A total of 100 fresh feces samples was collected from several pig farms in Bali, from Badung and Tabanan districts, each consisted of 50 samples. Pig feces samples were examined for the presence of eggs worms, cysts and oocysts for protozoa based on the morphology and size. Identification for protozoa and worms used native, sedimentation and sucrose flotation methods. Parameters measured were sex, feed and cage management. The result showed that the characteristic parameters for pigs in both district were generally female. Cage management for raising pigs mostly used group cage. Feed that provided in both district mostly used bran and concentrate. All of 100 pig feces samples that examined positive for parasites. There were 8 types of gastrointestinal parasites that have been identified. Four types of protozoa found were *Entamoeba* sp. (99%), *Balantidium* sp. (79%), *Eimeria* sp. (78%), *Blastocystis* sp. (69%) and four types of worms were *Ascaris* sp. (20%), *Trichuris* sp. (20%), *Strongyloides* sp. (19%), and *Oesophagostomum* sp. (8%). All pigs were infected with two or more parasites. The prevalence of parasitic gastrointestinal infections was different for each district, six genera (*Entamoeba* sp., *Balantidium* sp., *Blastocystis* sp., *Eimeria* sp., *Oesophagostomum* sp. and *Trichuris* sp.) were higher found in Tabanan district and the two genera (*Ascaris* sp. and *Strongyloides* sp.) were higher in Badung district. *Oesophagostomum* sp. was only found to infect pigs in Tabanan district. The conclusion is gastrointestinal parasites that found in pigs at Badung and Tabanan district Bali Province mostly have zoonotic potential.

Keywords: Zoonotic parasite, Gastrointestinal parasite, Pig, Bali Indonesia

ABSTRAK

Babi memiliki potensi untuk menularkan penyakit parasit gastrointestinal zoonotik yang disebabkan oleh protozoa dan cacing. Tujuan dari penelitian ini adalah untuk mengidentifikasi parasit gastrointestinal yang berpotensi zoonosis pada babi di provinsi Bali. Sebanyak 100 sampel feses segar dikumpulkan dari beberapa peternakan babi di Bali, dari kabupaten Badung dan Tabanan masing-masing terdiri dari 50 sampel. Sampel feses babi diperiksa terhadap keberadaan telur cacing, kista dan ookista protozoa berdasarkan morfologi dan ukuran. Identifikasi protozoa dan cacing menggunakan metode natif, sedimentasi dan flotasi sukrosa. Parameter yang diukur adalah jenis kelamin, pakan dan manajemen kandang. Hasil penelitian menunjukkan bahwa karakteristik parameter pada babi di kedua kabupaten umumnya betina. Manajemen kandang untuk beternak babi kebanyakan menggunakan kandang kelompok. Pakan yang disediakan di kedua kabupaten sebagian besar menggunakan dedak dan konsentrat. Dari total 100 sampel feses babi yang diperiksa positif terhadap parasit. Terdapat 8 jenis parasit gastrointestinal yang telah diidentifikasi. Empat jenis protozoa yang ditemukan adalah

Corresponding Author.

E-mail: tswant@gmail.com; Telp: +6281226094872

Entamoeba sp. (99%), *Balantidium* sp. (79%), *Eimeria* sp. (78%), *Blastocystis* sp. (69%) dan empat genus cacing yaitu: *Ascaris* sp. (20%), *Trichuris* sp. (20%), *Strongyloides*

sp. (19%), and *Oesophagostomum sp.* (8%). Setiap babi terinfeksi oleh dua atau lebih parasit. Prevalensi infeksi parasit gastrointestinal berbeda untuk tiap kabupaten, enam genus (*Entamoeba sp.*, *Balantidium sp.*, *Blastocystis sp.*, *Eimeria sp.*, *Oesophagostomum sp.* dan *Trichuris sp.*) lebih tinggi ditemukan di kabupaten Tabanan dan dua genus (*Ascaris sp.* dan *Strongyloides sp.*) lebih tinggi di Kabupaten Badung. *Oesophagostomum sp.* hanya ditemukan menginfeksi babi di kabupaten Tabanan. Kesimpulannya adalah parasit gastrointestinal yang ditemukan pada babi di Kabupaten Badung dan Tabanan Provinsi Bali sebagian besar memiliki potensi zoonosis.

Kata kunci: Parasit zoonotik, Parasit gastrointestinal, Babi, Bali Indonesia

How to Cite: Widisuputri, Ni Komang Aprilina; Suwanti, Lucia Tri; Plumeriastuti, Hani. A Survey for Zoonotic and Other Gastrointestinal Parasites in Pig In Bali Province, Indonesia. **Indonesian Journal of Tropical and Infectious Disease**, [S.l.], v. 8, n. 1, p. 55-66, mar. 2020. ISSN 2356-0991. Available at: <<https://ejournal.unair.ac.id/IJTID/article/view/10393>>.

Date accessed: 04 apr. 2020.doi:<http://dx.doi.org/10.20473/ijtid.v8i1.10393>.

INTRODUCTION

Pigs are one of the commodities in the livestock sector, which has great potential to be developed in the recent decades. The pig population in Indonesia continues to increase along with the increasing number of large-scale pig farms and individual pig farmers. One of the regions in Indonesia where most people raise pigs is in Bali Province. Bali Provincial Livestock Service¹ reports that the total pig population in 2016 reached 803,517. In Bali Province, pigs are an important commodity and most people in Bali maintain pigs as their primary and secondary business. In addition, pigs also play an important role in fulfilling daily food needs and as a complement to religious ceremonies.²

Generally, pigs in Bali are traditionally raised with low nutritional value and poor hygiene. This condition make pigs are more vulnerable to various diseases and has potential to spread the diseases.³ The existence of the diseases can cause considerable economic losses for pig farmers. Losses include a decrease in production due to inhibition of livestock growth and increase medical costs.⁴ One of the diseases that can infect pig is gastrointestinal parasites. Economic losses caused by gastrointestinal parasites were significant, but farmers may not realize it because the symptoms tend to be subclinical and pigs may still look healthy.⁵

Gastrointestinal parasites in pigs are protozoa and worms. The types of protozoa that can infect gastrointestinal tract of pigs include *Entamoeba sp.*; *Balantidium sp.*; *Eimeria sp.*;

and *Isospora sp.*⁶ Recent study by Yoshikawa *et al.*,⁷ in East Nusa Tenggara found the presence of protozoa *Blastocystis sp.* as much as 87.1%. Research about *Blastocystis sp.* in pigs in Bali Province, previously have not been reported. According to Suryastini *et al.*,⁸ several types of gastrointestinal worms that can infect pigs were *Gnathostoma hispidum*, *Hyostromylus rubidus*, *Macracanthorhynchus hirudinaceus*, *Globocephalus urosbulatus*, *Strongyloides ransomi*, *Ascaris suum*, *Oesophagostomum dentatum* and *Trichuris suis*.

Some gastrointestinal parasites in pigs have potentially to transmit zoonotic diseases to human. According to Schar *et al.*,⁹ there are five gastrointestinal parasites that can be detected in pigs with zoonotic potential, were *Ascaris sp.*, *Trichuris sp.*, *Capillaria spp.*, *Balantidium coli* and *Entamoeba sp.* In addition, Wang *et al.*,¹⁰ stated that *Blastocystis sp.* in pigs also had zoonotic potentially. It will certainly have an impact on the animal welfare as well as pig farmers and surrounding communities close to the farm area. Therefore, the aims of this study was to determine zoonotic and other gastrointestinal parasites in pig at Bali province, Indonesia based on fecal examination and discuss their zoonotic potential.

MATERIALS AND METHODS

Study Area

This study was conducted in two district in Bali: Badung and Tabanan districts. In Badung district



Figure 1. Map of Sampling Location. Dark Blue Colour is Badung District and Pink Colour is Tabanan District.

samples were taken in North Kuta sub-district, and in Tabanan district samples were taken in Baturiti sub-district. Geographically, Badung district located between $08^{\circ}14'20''$ - $08^{\circ}50'48''$ South latitude and $115^{\circ}05'00''$ - $115^{\circ}26'16''$ East longitude. North Kuta sub-district has an area of 33.86 km^2 with an altitude of 0-65 meters above sea level. North Kuta sub-district was located in the lowlands close to urban areas. Geographically, Tabanan district located between $08^{\circ}14'30''$ - $08^{\circ}30'07''$ South latitude and $114^{\circ}54'52''$ East longitude. Baturiti sub-district has an area of 99.17 km^2 with an altitude of 465-2082 meters above sea level. Baturiti sub-district was located in the highlands of rural areas. Dark blue colour is Badung district and pink colour is Tabanan district (**Figure 1**). A total of 100 pig fecal samples were taken randomly, from Badung and Tabanan districts consisted each 50 samples. Samples collection were conducted from 15 - 22 January 2018.

Feces Samples Collection

Feces samples from several pig farmers are taken directly using gloves from the ground and after defecation and accompanied by a veterinarian from the local livestock department. All feces samples were collected in urine steril container and were preserved in 2.0% potassium dichromate for protozoa examinations and 10% formalin for helminths examination, then stored in cool box for transportation. For each animal was recorded with different code. Parameters included sex, feed and cage management.

Examination of Feces Samples

Samples were observed at Veterinary Parasitology Laboratory, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya Indonesia. Samples were examined for eggs worm, cyst and oocyst for protozoa. Identification for protozoa and egg worm using native, sedimentation and sucrose flotation methods. Feces were diluted with aquadest and then filtered. For native examination, the feces sample is stirred first using a stirring rod and then a small portion of feces sample is taken and placed on the object glass and the lid uses a cover glass after that check under the microscope 400x magnification. For sediment examination, filtrate were centrifugation at 1.500 rpm for 5 minutes (by centrifuge HC 1180T 8 HOLE WITH TIMER, China), then removed supernatant. This step repeated until 3 times. Take the sediment slowly and place it on the object glass then cover with a cover glass. The remaining sediment was added with sucrose solution until complete 12 mL to be centrifuged at 1.500 rpm for 10 min in a 15 mL plastic tube. Floated was added sucrose solution until mouth of tube and was covered by a cover glass. After 5 min, cover glass was transferred to object glass, and the eggs of worm were observed at 100x magnification and the cysts and oocysts of protozoa were observed at 400x magnification for identification by light microscopy. Identification for both protozoa and worm were based on the morphology and size of the eggs, cysts or oocysts.^{11,12,13}

Table 1. Characteristic Parameters Pigs for Sampling

Characteristics		Places		Total		
		Badung District (n=50)	Tabanan District (n=50)			
Sex	Male	18	16	100		
	Female	32	34			
Feed	Bran + Concentrate	35	28	100		
	Bran + Concentrate + Banana trunk	7	9			
	Bran + Concentrate + Banana trunk + Leftovers house	5	0			
	Bran + Leftovers house	1	0			
	Bran + Concentrate + Banana trunk + Taro stems	0	9			
	Bran + Concentrate + Taro stems	0	3			
	Bran + Chicken innards+ Leftovers house	2	0			
	Bran + Banana trunk	0	1			
	Management	Individual cage	11		8	100
		Group cage	39		42	

RESULTS AND DISCUSSION

A total of 100 pig feces samples from Badung and Tabanan districts Bali province, Indonesia were identified. Information from each pig characteristics were provided in (Table 1). Table 1 shows that the majority of the pig population in Tabanan and Badung districts are female and feed given to almost pigs is bran and concentrate. In Badung district some pigs were fed by leftovers from the kitchen while in Tabanan district some pigs were fed using plant origin ingredients, banana stems and taro leaves. The cage management in both districts mostly pig farmers are using group cages.

The results of identification indicate that the pigs in Bali are infected by 8 genera of parasites: *Entamoeba* sp., *Balantidium* sp., *Eimeria* sp., *Blastocystis* sp., *Strongyloides* sp., *Trichuris* sp., *Ascaris* sp. and *Oesophagostomum* sp. The morphological of the gastrointestinal parasites found in pigs in Bali Province are described in Figure 2.

All of the feces samples that have been examined, overall positive for gastrointestinal parasites (Table 2). It means all of pigs were infected with gastrointestinal parasites. The highest prevalence was *Entamoeba* sp. (99%) respectively, was

followed by *Balantidium* sp. (79%), *Eimeria* sp. (78%), *Blastocystis* sp. (69%), *Ascaris* sp. (20%), *Trichuris* sp. (20%), *Strongyloides* sp. (19%), and *Oesophagostomum* sp. (8%). The prevalence of parasitic gastrointestinal infections was different for each district, six genera (*Entamoeba* sp., *Balantidium* sp., *Blastocystis* sp., *Eimeria* sp., *Oesophagostomum* sp. and *Trichuris* sp.) were higher found in Tabanan district and the two genera (*Ascaris* sp. and *Strongyloides* sp.) were higher in Badung district. *Oesophagostomum* sp. was only found to infect pigs in Tabanan.

One pig could infected with two or more parasites, even, the pigs were infected with seven species of parasites. In detail, the mix infection was presented in Table 3. Almost all of mix infections involve *Entamoeba* sp. There is no single infection.

In Indonesia, especially in Bali Province, studies about gastrointestinal parasites have been widely reported. However, most of these studies focus on one type of parasite. There have not been many studies that discuss about mixed infection between protozoa and worms in each pig. From the results of this study showed that gastrointestinal parasites in pigs in Badung and Tabanan districts found several parasites that have zoonotic potential.

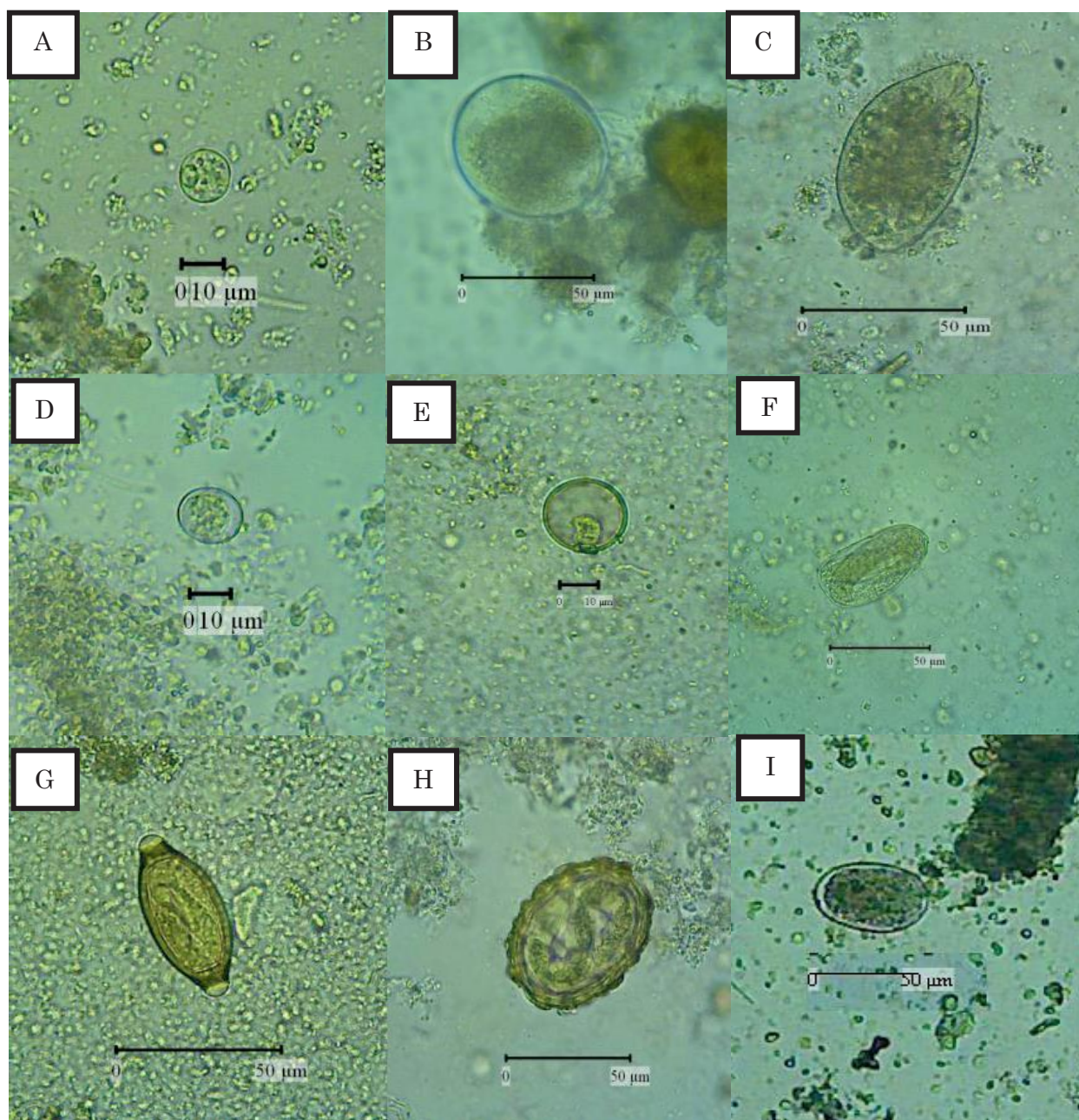


Figure 2. Morphology of Gastrointestinal Parasites in Pig in Bali Province Under Light Microscope. A). *Entamoeba* sp. (Bar: 10µm); B) and C). *Balantidium* sp. Cyst and Trophozoite (Bar: 50µm); D). *Eimeria* sp. (Bar: 10µm); E). *Blastocystis* sp. (Bar: 10µm); F). *Strongyloides* sp. (Bar: 50µm); G). *Trichuris* sp. (Bar: 50µm); H). *Ascaris* sp. (Bar: 50µm); and I). *Oesophagostomum* sp. (Bar: 50µm).

Table 2. Prevalence of Gastrointestinal Parasites Infections in Pig in Bali Province based on Each Genus of Parasite

Places	Samples	Number of Positive (%)							
		En	Ba	Bl	Ei	As	Oe	St	Tr
Badung District	50	49(100)	34(76)	35(70)	29(48)	12(24)	0(0)	13(26)	5(10)
Tabanan District	50	50(100)	45(90)	34(68)	49(98)	8(16)	8(16)	5(10)	15(30)
Total	100	99(99)	79(79)	69(69)	78(78)	20(20)	8(8)	18(18)	20(20)

En, *Entamoeba* sp.; Ba, *Balantidium* sp.; Bl, *Blastocystis* sp.; Ei, *Eimeria* sp.; As, *Ascaris* sp.; Oe, *Oesophagostomum* sp.; St, *Strongyloides* sp.; Tr, *Trichuris* sp.

Table 3. Prevalence Gastrointestinal Parasites in Pig in Bali Province based on Mix Infection

Parasites	Number of Positive (%)		
	Badung District (n=50)	Tabanan District (n=50)	Total (n=100)
En+Ba	2 (4)	0 (0)	2
En+Bl	4 (8)	0 (0)	4
En+Ba+Bl	7 (14)	1 (2)	8
En+Ba+Ei	7 (14)	5 (10)	12
En+Bl+Ei	4 (8)	0 (0)	4
En+Bl+As	2 (4)	0 (0)	2
En+Ei+Oe	0 (0)	1 (2)	1
En+Ei+St	0 (0)	1(2)	1
En+Ei+Tr	0 (0)	1 (2)	1
En+Ba+Bl+Ei	3 (6)	13 (26)	16
En+Ba+Bl+As	3 (6)	0 (0)	3
En+Ba+Bl+St	2 (4)	0 (0)	2
En+Ei+As+St	2 (4)	0 (0)	2
Ba+Bl+Ei+St	1 (2)	0 (0)	1
En+Bl+Ei+St	3 (6)	0 (0)	3
En+Bl+Ei+Tr	0 (0)	1 (2)	1
En+Ba+Ei+As	1 (2)	2 (4)	3
En+Ba+Ei+Oe	0 (0)	3 (6)	3
En+Ba+Ei+Tr	2 (4)	2 (2)	4
En+Ba+Ei+St+Tr	1 (2)	0 (0)	1
En+Ba+Bl+As+St	1 (2)	0 (0)	1
En+Ba+Bl+Ei+As	1 (2)	4 (8)	5
En+Ba+Bl+Ei+Oe	0 (0)	3 (6)	3
En+Ba+Bl+Ei+St	1 (2)	1 (2)	2
En+Ba+Bl+Ei+Tr	1 (2)	9 (18)	10
En+Ba+Ei+As+St+Tr	0 (0)	1 (2)	1
En+Bl+Ei+As+St+Tr	0 (0)	1 (2)	1
En+Ba+Bl+Ei+Oe+St	0 (0)	1 (2)	1
En+Ba+Bl+Ei+As+St	1 (2)	0 (2)	1
En+Ba+Bl+Ei+As+St+Tr	1 (2)	0 (0)	1

En, *Entamoeba* sp.; Ba, *Balantidium* sp.; Bl, *Blastocystis* sp.; Ei, *Eimeria* sp.; As, *Ascaris* sp.; Oe, *Oesophagostomum* sp.; St, *Strongyloides* sp.; Tr, *Trichuris* sp.

Protozoa are the most common parasites that infect pigs in both districts. The higher prevalence of protozoa is dominated by *Entamoeba* sp. (100%). This result was higher than the study by Suryawan *et al.*,¹⁴ which stated that out of 102 faecal samples of pigs in Papua, 34.2% were infected with *Entamoeba* sp. Research by Agustina *et al.*,¹⁵ in Bali Province found that the prevalence of *Amoeba* sp. in pig fecal samples

as much as 82.4%. This is certainly a concern, because all pig samples examined in this study were 100% positive for *Entamoeba* sp.

Entamoeba sp. is a protozoa that can infect human and animals. According to Matsubayashi *et al.*,¹⁶ states that there are 6 species from genus *Entamoeba* that have been identified to infect human and animals, namely *E. histolytica*, *E. polecki*, *E. coli*, *E. dispar*, *E. moshkovskii* and

E. Hartmanni. Research by Gomez *et al.*,¹⁷ from samples of pigs and human on four pig farms in Colombia showed that pig faecal samples were positive for *E. coli*, human faecal samples were also positive for *E. coli* and *E. hystolitica / dispar*. The presence of *E. coli* species in pigs and humans in Colombia shows the possibility of zoonotic potential of these parasites, so further molecular identification needs to be done. However, study by Agustina *et al.*,¹⁸ about the incidence of *Entamoebiasis* in pigs in Bali Province showed negative PCR results on *E. polecki*, so the zoonotic potential needs to be studied further.

In this study, another protozoa found was *Balantidium* sp. The prevalence in this study was 83%. In Indonesia, the incidence of *Balantidium* sp. in pigs had been widely studied by Agustina *et al.* and Yuliari *et al.*,^{18,19} with a prevalence of 61.2%, and 36.4%, respectively. In Korea⁶ was recorded the prevalence of *Balantidium* sp. in pigs was 64.7%, in China²⁰ was 22.79%, and in Cambodia⁹ was 15.8%.

Balantidium sp. is a protozoa that can cause balantidiosis. Balantidiosis is a zoonotic disease that can infect human and animals through the world. Pigs are natural reservoir for *Balantidium* sp. Transmission of the disease by faecal-oral route. In pigs it is usually asymptomatic and these protozoa live in the lumen of the cecum and colon. Transmission between human and animals can occur as well as humans to humans. In human, the incidence of balantidiosis can be asymptomatic. Severe infection can cause diarrhea and abdominal discomfort. Balantidiosis can occur due to several factors, such as sanitation, climate conditions, and community culture. An important factor in the spread of disease to humans is the presence of infected pigs and careless disposal of animal waste. This often occurs in poor rural areas where people tend to live near their livestock, so the disease is easily spread. Some sectors that have a high risk of being infected by *Balantidium* sp. are veterinarians, animal handlers and butchers.^{21,22}

Eimeria sp. is a protozoa that can cause coccidiosis. The prevalence of *Eimeria* sp. in this study was 83%, higher than the study Yuliari *et al.*,¹⁹ in pigs in Papua, Indonesia,

with an average prevalence was 68.2%. In Bali Province, the prevalence of *Eimeria* sp. in pigs was reported by Agustina *et al.*,¹⁵ as much as 54.8%. The incidence of coccidiosis in several countries has also been reported^{13,20,23,24,25} with a prevalence 16.53%, 16.7%, 47%, 89.2% and 3%, respectively. Coccidiosis in young pigs can cause diarrhea and can be predispose to secondary infections by viruses or bacteria. In severe cases, pigs can become dehydrated with a 10-59% chance of death. Animals that have been repeatedly infected have no clinical symptoms, and can transmit to other animals and pollute the surrounding environment.¹⁵

Research about *Blastocystis* sp. in pigs in Bali Province, previously have not been reported. In this study, the prevalence of *Blastocystis* sp. in pigs was 60%. In Indonesia, research on *Blastocystis* sp. was reported for the first time⁷ and *Blastocystis* sp. was found in humans, pigs, chickens and rodents in the Winyapu area, Southwest Sumba District, East Nusa Tenggara Province, and evidenced by PCR methods. So far, there are 17 *Blastocystis* sp. subtypes that have been identified based on gen analysis of small subunits ribosomal RNA (SSU rRNA).²⁶ Humans can be infected by 9 subtypes (ST1-ST9).²⁷ In China²⁸ was reported that there were 3 zoonotic subtypes in pigs, namely ST1, ST3 and ST5, which showed that *Blastocystis* sp. in pigs could be zoonotic.

Several factors that related to the emergence of *Blastocystis* sp. infection are lack of the environmental hygiene, poor community sanitation, socio-economic status and lifestyle. *Blastocystis* sp. can infect humans and some animals including pigs, cows, monkeys and chickens. Some zoonotic subtypes of these animals have been isolated, therefore, they can act as reservoir hosts. Transmission can occur from human to human, from human to animal and from animal to human by faecal-oral route.^{29,30}

In this study found various types of nematode worms namely *Strongyloides* sp., *Trichuris* sp., *Ascaris* sp. and *Oesophagostomum* sp. This result is also evidenced by the existence of investigations in Indonesia found various types of worms that often infect pigs. Study by Agustina³¹

in pigs in Bali found *Oesophagostomum* sp. with the prevalence of 47.5%. In addition, research by Fendryanto *et al.*,³ on piglets in Bali found the prevalence of *Ascaris* sp., *Trichuris* sp. and *Strongyloides* sp. with the prevalence of 33.2%, 14.0% and 57.6%, respectively. In Poland, study by Wictor and Jarosz³² noted the prevalence of worms in pigs was found *Ascaris* sp. (22.2%), *Trichuris* sp. (5.6%), *Strongyloides* sp. (36.1%) and *Oesophagostomum* sp. (36.1%). In Malaysia²⁵ noted the prevalence of *Strongyloides* sp. (45.6%) and *Trichuris* sp. (8.7%). In Cambodia, Inpankaew *et al.*,³³ noted the prevalence of *Oesophagostomum* sp. (76.6%), *Strongyloides ransomi* (23.3%), *Ascaris suum* (13.3%) and *Trichuris suis* (6.6%). Research by Nonga and Paulo³⁴ in Tanzania showed that differences in the prevalence of gastrointestinal worms in some areas may arise due to differences in environmental conditions that are conducive to the parasite survival, the number of definitive hosts infected, type of feed and animal diet and the hosts immune system.

Strongyloides sp. is an important parasite that can be infected most of the suckling piglets. The worms predilection is in the small intestine. Common clinical symptoms that may occur are diarrhea followed by progressive dehydration. In severe infections, death usually occurs before piglets are between 10 and 14 days old, but if piglets can survive, dwarfism can occur. Recent research by Giang *et al.*,³⁵ states that the type of *Strongyloides* sp. in pigs in Vietnam based on molecular identification is *S. ransomi*. *S. ransomi* has a similar morphology to *S. papillosus*, but in molecular analysis based on 18S rDNA, *S. ransomi* is close to *S. venezuelensis*. The zoonotic aspect and importance of *Strongyloides* sp. in veterinary medicine are discussed more detail in Thamsborg *et al.*,³⁶ which states that until now *S. ransomi* in pigs has not been zoonotic, but there are other species such as *S. stercoralis* in dogs have zoonotic potential to humans.

Trichuris sp. is a type of worm that commonly infect pigs and live in the large intestine. Pigs are considered as the natural host of *Trichuris* sp, although primates and humans may be infected. *Trichuris* sp. infection can cause ulceration in the

lining of the intestinal mucosa, damage to blood capillaries and secondary infections can occur by bacteria. Clinical symptoms in pigs include anorexia, slimy and bloody diarrhea, dehydration and death occur in severe cases. *Trichuris* sp. can survive for several years outside the hosts. So far, it is still a question of whether or not *Trichuris* sp. is zoonotic. According to Nejsum *et al.*,³⁷ stated that the species *Trichuris trichiura* in humans can be found in pigs, but until now most worms did not survive. This shows that human cross-infection can occur with *T. suis* in pigs under experimental conditions.

Ascaris sp. is disease that can cause ascariasis and commonly found in pigs. This typical worm species also found in wild pigs. If pig infected with a severe infection, intestinal obstruction can occur, loss of appetite, vomiting, jaundice and death. In the case of moderate infection can occur low appetite, low food efficiency and slow growth. *Ascaris* sp. is zoonotic and can infect humans and other mammals by consuming food or water contaminated by infective eggs. *Ascaris* sp. eggs in a dry environment can last 2 to 4 weeks, while in a humid and cold environment they can survive eight weeks and become an infective stage in the environment. After ingestion, eggs hatch into larvae through the intestinal wall, pass through the liver and migrate to the lungs, and adult worms have a predilection in the small intestine.³⁸ The occurrence of zoonosis *Ascaris* sp. has been reported³⁹ which identified 14 cases of ascariasis in humans in contact with pigs in Maine, USA. In addition, research conducted by Nejsum *et al.*,⁴⁰ stated that ascariasis is a case of zoonosis in Denmark, where humans are in direct contact with pigs and pig feces.

In this study, the prevalence of *Oesophagostomum* sp. only found in Tabanan district. *Oesophagostomum* sp. is known as a worm nodule that has predilection in the large intestine in cecum and colon. *Oesophagostomum* sp. worm infection occurs when pigs eat plants or foods that contaminated by infective larvae³¹. *Oesophagostomum* sp. infection in pigs can cause lack of appetite, poor growth rates, easy secondary infection and can cause death⁴¹. So far there have been no studies that discuss the

possibility of zoonosis of *Oesophagostomum* sp. in pigs.

In this study, all pig were infected with mixed parasite protozoa and worms. According to Tolistiawaty *et al.*,⁴² parasitic infections generally occur due to the weakness resistance of the animal to parasites. Mixed infections often occur, and making it difficult to know the specific symptoms that seen. Infection that occurs is usually caused by several types of worms in the intestine and other organs. The way of animal treatment also very influential on the incidence of gastrointestinal parasitic infections. This is supported by research from Supriadi *et al.*,⁴³ which was stated that gastrointestinal parasitic infections in pigs can be caused by poor management. Poor cage sanitation is also a factor that increases the risk of parasitic infection and does not rule out the possibility of transmission to humans, especially for pig owners (zoonosis). In addition, according to Roesel *et al.*,⁴⁴ stated that the most important factors associated with gastrointestinal parasitic infections in pigs are related to sanitation, especially cleaning of pig stool regularly from the cage and the use of disinfectants.

In Badung and Tabanan districts, most people use group cages to raising pigs. This type of maintenance system includes intensive maintenance where the pig is caged in a cage. According to Lai *et al.*,²⁰ raised pigs traditionally have a higher prevalence of the disease, this is because intensive pig farming has better maintenance management. Although intensive maintenance implements better management, it seems that it cannot help reduce the incidence of disease infection effectively. The possibility of a parasitic infection occurs due to a lack of public awareness about the good sanitation, besides that habit from pigs by eat in soil contaminated with faeces can be predispose to infection. Research by Mutua *et al.*,⁴⁵ stated that pig needs energy, amino acids, minerals, vitamins and water. These elements are needed for the process of growth, reproduction and lactation.

CONCLUSION

Gastrointestinal parasites that found in pigs in Badung and Tabanan districts Bali Province mostly have zoonotic potential. These parasites included *Entamoeba* sp., *Balantidium* sp., *Eimeria* sp., *Blastocystis* sp., *Strongyloides* sp., *Trichuris* sp., *Ascaris* sp. and *Oesophagostomum* sp. This study is expected to provide information to improve the hygiene and sanitation in terms of raising pigs, to provide a basis for further control and treatment in pigs that infected with gastrointestinal parasites as well as providing information about zoonotic potential that can arise.

ACKNOWLEDGEMENTS

The author would like to thank the Department of Parasitology, Faculty of Veterinary Medicine, Universitas Airlangga for supporting this research. Thank you to the Regional Development Planning Agency of Badung and Tabanan Bali district for giving permission to take samples and I would like to thank the Agency of Animal Husbandry and Fisheries and field officers who have helped me so that this research can be done in accordance with the expected time.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest for this research.

REFERENCES

1. Bali Provincial Animal Husbandry. Information on Livestock Data in Bali Province in 2016. Bali: Bali Province Animal Husbandry; 2016.
2. Oka IBM, Dwinata IM. Strongyloidiasis in Pre-weaned Piglets. *Bul Vet Udayana* [Internet]. 2011 [cited 2018 Sep 12];3(2). Available from: [http://download.portalgaruda.org/article.php?article=13828&val=941&title=Strongyloidosis Pada Anak Babi Pra-Sapih](http://download.portalgaruda.org/article.php?article=13828&val=941&title=Strongyloidosis+Pada+Anak+Babi+Pra-Sapih)
3. Fendriyanto A, Dwinata IM, Oka IBM, Agustina KK. Identification and Prevalence of Gastrointestinal Nematode Worms in Pigs in Bali. *Indones Med Veterinus*. 2015;4(5).

4. FAO. Swine Health Management. Food and Agriculture Organization of the United Nations; 2012.
5. Kumsa B, Kifle E. Internal parasites and health management of pigs in Burayu District, Oromia Regional State, Ethiopia. *J S Afr Vet Assoc* [Internet]. 2014 Feb 26 [cited 2018 Sep 12];85(1):913. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24831203>
6. Ismail HAHA, Jeon H-K, Yu Y-M, Do C, Lee Y-H. Intestinal parasite infections in pigs and beef cattle in rural areas of Chungcheongnam-do, Korea. *Korean J Parasitol* [Internet]. Korean Society for Parasitology; 2010 Dec [cited 2018 Sep 12];48(4):347–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21234241>
7. Yoshikawa H, Tokoro M, Nagamoto T, Arayama S, Asih PBS, Rozi IE, Syafruddin D. Molecular survey of *Blastocystis* sp. from humans and associated animals in an Indonesian community with poor hygiene. *Parasitol Int* [Internet]. 2016 Dec [cited 2018 Sep 12];65(6):780–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27080248>
8. Suryastini KAD, Dwinata IM, Damriyasa IM. Accuracy of the Ritchie Method in Detecting Gastrointestinal Worm Infection in Pigs. *Indones Med Veterinus*. 2012;1(5).
9. Schär F, Inpankaew T, Traub RJ, Khieu V, Dalsgaard A, Chimnoi W, Chhoun C, Sok D, Marti H, Muth S, Odermatt P. The prevalence and diversity of intestinal parasitic infections in humans and domestic animals in a rural Cambodian village. *Parasitol Int* [Internet]. 2014 Aug [cited 2018 Sep 12];63(4):597–603. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24704609>
10. Wang W, Owen H, Traub RJ, Cuttall L, Inpankaew T, Bielefeldt-Ohmann H. Molecular epidemiology of *Blastocystis* in pigs and their in-contact humans in Southeast Queensland, Australia, and Cambodia. *Vet Parasitol*. Elsevier B.V.; 2014;203(3–4):264–9.
11. Meutchieye F, Kouam MK, Miegoué E, Nguafack TT, Tchoumboué J, Téguia A, Theodorououlos G. A survey for potentially zoonotic gastrointestinal parasites in domestic cavies in Cameroon (Central Africa). *BMC Vet Res* [Internet]. BioMed Central; 2017 Dec 26 [cited 2018 Sep 12];13(1):196. Available from: <http://bmcvetres.biomedcentral.com/articles/10.1186/s12917-017-1096-2>
12. Krishna Murthy CM, Ananda KJ, Adeppa J, Sathesha MG. Studies on gastrointestinal parasites of pigs in Shimoga region of Karnataka. *J Parasit Dis*. 2016;40(3):885–9.
13. Nathaniel AO, Anyika KC, Frank MC, Jatau JD. Prevalence of Gastro-Intestinal Parasites in Pigs in Jos South Local Government Area of Plateau State, Nigeria. *Haya Saudi J Life Sci* [Internet]. 2017 [cited 2018 Sep 13];2(5). Available from: <http://scholarsmepub.com/>
14. Suryawan GY, Suratma NA, Damriyasa IM. Potential of Pigs as a Source of Transmission of Zoonosis *Entamoeba* spp. *Bul Vet Udayana*. 2014;6(2).
15. Agustina KK, Sudewi NMAA, Dharmayudha AAGO, Oka IBM. Identification And Prevalence Of Gastrointestinal Protozoa In Piglets That Sold In A Traditional Market In Bali. *Bul Vet Udayana* [Internet]. 2016 [cited 2018 Sep 12];8(1). Available from: <https://ojs.unud.ac.id/index.php/buletinvet/article/view/19667>
16. Matsubayashi M, Murakoshi N, Komatsu T, Tokoro M, Haritani M, Shibahara T. Genetic identification of *Entamoeba polecki* subtype 3 from pigs in Japan and characterisation of its pathogenic role in ulcerative colitis. *Infect Genet Evol* [Internet]. 2015 Dec [cited 2018 Sep 12];36:8–14. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26318541>
17. Mendoza-Gómez MF, Bact, Pulido-Villamarín A, Barbosa-Buitrago A, Aranda-Silva M. Presence of gastrointestinal parasites in swine and human of four swine production farms in Cundinamarca- Colombia. *Rev MVZ Córdoba* [Internet]. Universidad de Córdoba; 2015 [cited 2018 Sep 12];20:5014–27. Available from: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0122-02682015000400015
18. Agustina KK, Dharmayudha AAGO, Oka IBM, Dwinata IM, Kardena IM, Dharmawan NS, Damriyasa IM. Case of Entamoebiasis in Pigs Raised with a Free Range Systems in Bali, Indonesia (Kasus Entamoebiasis Pada Babi Yang Dipelihara Dengan Cara Di umbar Di Bali, Indonesia). *J Vet* [Internet]. 2016 [cited 2018 Sep 12];17(4):570–5. Available from: <https://ojs.unud.ac.id/index.php/jvet/article/view/26559>
19. Yuliari PK, Damriyasa IM, Dwinata IM. Prevalence of Protozoa Digestive tract in pigs in the Baliem Valley and the Arfak Mountains of Papua. *Indones Med Veterinus*. 2013;2(2).
20. Lai M, Zhou RQ, Huang HC, Hu SJ. Prevalence and risk factors associated with intestinal parasites in pigs in Chongqing, China. *Res Vet Sci* [Internet]. 2011 Dec [cited 2018 Sep 13];91(3):e121–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21349561>
21. Sangioni LA, Botton S de A, Ramos F, Cadore GC, Monteiro SG, Brayer Pereira DI, Vogel FSF. *Balantidium coli* in Pigs of Distinct Animal Husbandry Categories and Different Hygienic-Sanitary Standards in the Central Region of Rio Grande do Sul State, Brazil. *Acta Sci Vet*. 2017;45(June):1–6.
22. Schuster FL, Ramirez-Avila L. Current World Status of *Balantidium coli*. *Clin Microbiol Rev* [Internet]. 2008 Oct 1 [cited 2018 Sep 13];21(4):626–38. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/18854484>
23. Zhang WJ, Xu LH, Liu YY, Xiong BQ, Zhang QL, Li FC, Song QQ, Khan MK, Zhou YQ, Hu M, Zhao J. Prevalence of coccidian infection in suckling piglets in China. *Vet Parasitol* [Internet]. 2012 Nov 23 [cited 2018 Sep 13];190(1–2):51–5. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22694832>
24. Tsunda, G. YBW a. Porcine Coccidiosis: Prevalence Study in Ganye Southeastern Admawa State,

- Nigeria [Internet]. 2013 [cited 2018 Sep 13]. Available from: <https://www.semanticscholar.org/paper/Porcine-Coccidiosis-%3A-Prevalence-Study-in-Ganye-%2C-Tsunda-Y.B.Wanga./a2414e6d691de7496a63394682a651565ca99946>
25. Mat Yusof A, Md Isa ML. Prevalence of gastrointestinal nematodiasis and coccidiosis in goats from three selected farms in Terengganu, Malaysia. *Asian Pac J Trop Biomed* [Internet]. No longer published by Elsevier; 2016 Sep 1 [cited 2018 Sep 13];6(9):735–9. Available from: <https://www.sciencedirect.com/science/article/pii/S2221169116301873>
 26. Alfellani MA, Taner-Mulla D, Jacob AS, Imeede CA, Yoshikawa H, Stensvold CR, Clark CG. Genetic Diversity of *Blastocystis* in Livestock and Zoo Animals. *Protist* [Internet]. 2013 Jul [cited 2018 Sep 13];164(4):497–509. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23770574>
 27. Wawrzyniak I, Poirier P, Viscogliosi E, Dionigia M, Texier C, Delbac F, Alaoui HE. *Blastocystis*, an unrecognized parasite: an overview of pathogenesis and diagnosis. *Ther Adv Infect Dis* [Internet]. 2013 Oct 12 [cited 2018 Sep 13];1(5):167–78. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25165551>
 28. Song J-K, Hu R-S, Fan X-C, Wang S-S, Zhang H-J, Zhao G-H. Molecular characterization of *Blastocystis* from pigs in Shaanxi province of China. *Acta Trop* [Internet]. 2017 Sep [cited 2018 Sep 13];173:130–5. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/28619673>
 29. Tan KSW. New Insights on Classification, Identification, and Clinical Relevance of *Blastocystis* spp. *Clin Microbiol Rev* [Internet]. 2008 Oct 1 [cited 2018 Sep 13];21(4):639–65. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/18854485>
 30. Palasuwan A, Palasuwan D, Mahittikorn A, Chiabchalard R, Combes V, Popruk S. Subtype Distribution of *Blastocystis* in Communities along the Chao Phraya River, Thailand. *Korean J Parasitol* [Internet]. Korean Society for Parasitology; 2016 Aug [cited 2018 Sep 13];54(4):455–60. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27658597>
 31. Agustina KK. Identification and Prevalence of Strongyle Type Worms in Pigs in Bali. *Bul Vet Udayana*. 2013;5(2).
 32. Mizgajska-Wiktor H, Jarosz W. Potential risk of zoonotic infections in recreational areas visited by *Sus scrofa* and *Vulpes vulpes*. Case study--Wolin Island, Poland. *Wiad Parazytol* [Internet]. 2010 [cited 2018 Sep 13];56(3):243–51. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21174955>
 33. Inpankaew T, Murrell KD, Pinyopanuwat N, Chhoun C, Khov K, Sem T, Sorn S, Muth S, Dalsgaard A. A survey for potentially zoonotic gastrointestinal parasites of dogs and pigs in Cambodia. *Acta Parasitol* [Internet]. 2015 Jan 1 [cited 2018 Sep 13];60(4):601–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26408577>
 34. Nonga HE, Paulo N. Prevalence and intensity of gastrointestinal parasites in slaughter pigs at Sanawari slaughter slab in Arusha, Tanzania. *Livest Res Rural Dev*. 2015;27.
 35. Giang NTH, Hoan TD, Huyen NTT, Lan NTK, Doanh PN. Morphological And Molecular Characterisation Of *Strongyloides ransomi* (Nematoda: Strongyloididae) Collected From Domestic Pigs In Bac Giang Province, Vietnam. *Tap Chi Sinh Hoc*. 2017;39(3).
 36. Thamsborg SM, Ketzis J, Horii Y, Matthews JB. *Strongyloides* spp. infections of veterinary importance. *Parasitology* [Internet]. 2017 Mar 4 [cited 2018 Sep 13];144(3):274–84. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27374886>
 37. Nejsum P, Betson M, Bendall RP, Thamsborg SM, Stothard JR. Assessing the zoonotic potential of *Ascaris suum* and *Trichuris suis*: looking to the future from an analysis of the past. *J Helminthol* [Internet]. 2012 Jun 19 [cited 2018 Sep 13];86(2):148–55. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22423595>
 38. Midha A, Janek K, Niewianda A, Henklein P, Guenther S, Serra DO, Schlosser J, Hengge R, Hartmann S. The Intestinal Roundworm *Ascaris suum* Releases Antimicrobial Factors Which Interfere With Bacterial Growth and Biofilm Formation. *Front Cell Infect Microbiol* [Internet]. 2018 Aug 7 [cited 2019 Apr 7];8:271. Available from: <https://www.frontiersin.org/article/10.3389/fcimb.2018.00271/full>
 39. Miller LA, Colby K, Manning SE, Hoenig D, McEvoy E, Montgomery S, Mathison B, de Almeida M, Bishop H, Dasilva A, Sears S. Ascariasis in Humans and Pigs on Small-Scale Farms, Maine, USA, 2010–2013. *Emerg Infect Dis* [Internet]. 2015 Feb [cited 2018 Sep 13];21(2):332–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25626125>
 40. Nejsum P, Parker ED, Frydenberg J, Roepstorff A, Boes J, Haque R, Astrup I, Prag J, Skov Sorensen UB. Ascariasis Is a Zoonosis in Denmark. *J Clin Microbiol* [Internet]. 2005 Mar 1 [cited 2018 Sep 13];43(3):1142–8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15750075>
 41. Jufare A, Awol N, Tadesse F, Tsegaye Y, Hadush B. Parasites of pigs in two farms with poor husbandry practices in Bishoftu, Ethiopia. *Onderstepoort J Vet Res* [Internet]. 2015 Apr 30 [cited 2018 Sep 13];82(1):839. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26017194>
 42. Tolistiawaty I, Wdjaja J, Lobo LT, Isnawati R. Gastrointestinal Parasites in Livestock at the Sigi District Slaughterhouse, Central Sulawesi. *Balaba*. 2016;12(2).
 43. Supriadi, Muslihin A, Roesmanto B. Pre-Elimination of Gastrointestinal Parasites in Pigs From Suranadi Village, Narmada District, West Lombok. *Media Bina Ilm*. 2014;8(5).
 44. Roesel K, Dohoo I, Baumann M, Dione M, Grace D, Clausen P-H. Prevalence and risk factors for

gastrointestinal parasites in small-scale pig enterprises in Central and Eastern Uganda. *Parasitol Res* [Internet]. Springer Berlin Heidelberg; 2017 Jan 26 [cited 2018 Sep 13];116(1):335–45. Available from: <http://link.springer.com/10.1007/s00436-016-5296-7>

45. Mutua FK, Dewey C, Arimi S, Ogara W, Levy M, Schelling E. A description of local pig feeding systems in village smallholder farms of Western Kenya. *Trop Anim Health Prod* [Internet]. 2012 Aug 5 [cited 2018 Sep 13];44(6):1157–62. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22219174>