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Investigation of Intestinal Parasites in Pig Feces That Are also Human Pathogens

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SUMMARY: A total of 238 pig fecal specimens were collected from pig farms in Çorlu (Tekirdağ), Ayazma, and Arnavutköy (Istanbul) during the summer. Out of the 238 pig specimens, 105 were from pigs younger than 6 months and 133 from pigs older than 6 months. These were investigated for intestine parasites in particular the ones that are human pathogens. *Cryptosporidium* spp. was detected In 21 fecal specimens (8.8%), *Giardia* spp. in 9 (3.7%), *Balantidium coli* cysts in 4 (1.6%) and *Ascaris suum* eggs in 9 (4.1%). *Giardia lamblia* were found in 8 (7.6%) of 105 pigs younger than 6 months, *Cryptosporidium* spp. in 12 (11.4%), *Balantidium coli* cysts in 2 (1.5%). In the pigs older than 6 months *Giardia lamblia* were found in 1 (0.7%), *Cryptosporidium* spp. in 9 (6.7%), *Balantidium coli* cysts in 2 (1.5%). and *Ascaris suum* eggs in 9 (6.7%). The difference in the rate of *G. lamblia* (p=0.01) in pigs less than 6 months and of *A. suum* in those over 6 months was found to be statistically significant (p=0.005). Our results revealed that pigs are important sources of these parasites.

Key Words: Pig, intestinal parasites

Domuz Dışkılarında İnsan Sağlığı Bakımından Önem Taşıyan Bağırsak Parazitlerinin Araştırılması

ÖZET: Bu çalışmada Çorlu (Tekirdağ), Ayazma, Arnavutköy (İstanbul)'de bulunan domuz çiftliklerinden yaz döneminde toplanan 105'i 6 aydan küçük, 133'ü ise 6 aydan büyük olmak üzere toplam 238 domuzdan toplanan dışkı örnekleri özellikle insan patojeni olan bağırsak parazitleri yönünden incelenmiştir. Dışkı örneklerinin 21'inde (%8,8) *Cryptosporidium* spp., 9'unda (%3,7) *Giardia lamblia* , 4'ünde (%1,6) *Balantidium coli* ve 9'unda (%4,1) *Ascaris suum* belirlenmiştir. 6 aydan küçük 105 domuzun 8'inde (%7,6) *G. lamblia*, 12'sinde (%11,4) *Cryptosporidium* spp. ve 2'sinde *Balantidium coli* belirlenirken, 6 aydan büyük 133 domuz dışkısının 1'inde (%0,7) *G. lamblia*, 9'unda (%6,7) *Cryptosporidium* spp., 2'sinde (%1,5) *Balantidium coli* kistleri ve 9'unda (%4,1) *Ascaris suum* yumurtaları belirlenmiştir. *G. lamblia* için aradaki farkın istatistiksel olarak yavru domuzlarda (p=0.01) ve *A.suum* için ise altı aydan büyük domuzlarda anlamlı olduğu saptanmıştır (p = 0.005). Sonuçlarımız domuzların insan sağlığı için önem taşıyan bu parazitler bakımından bir kaynak oluşturduğunu göstermiştir.

Anahtar Sözcükler: Domuz, bağırsak parazitleri

INTRODUCTION

Giardia lamblia and *Cryptosporidium* spp. are common pathogens found both in human and animal intestines. *G. lamblia* is found in human, dog, cat and many other animals in the nature, whereas *Cryptosporidium* spp. are particularly common among human and calf although they may be also found among dogs, cats, horses, pigs and other animals (27, 40). Despite many studies demonstrating the presence of *Cryptosporidium* and *Giardia* in calf, a limited number of studies have been performed in various countries to show its presence in cattle, pigs, sheep and dogs (6, 27, 30).

G. lamblia is common worldwide and is the most common intestinal protozoon among humans. *G. lamblia* colonizes at the small intestines of humans and animals, causing mild to severe diarrhea. Children and immune compromised people are more susceptible. *G. lamblia* transmits via fecal-oral route in humans (29).

However, contaminated water and food have role in transmission. *G. lamblia* is the most common parasites of wild and domestic animals. Its prevalence among pigs has been reported as 8.5%, 7.6% and 9% for Canada, USA and Europe, respectively (3, 27, 29). *Cryptosporidium parvum* is a coccidian protozoon able to colonize in the small intestine of human and many mammalians. Severe intestinal infections caused by this parasite have been reported during the last 30 years. *C. parvum* infects human beings, various domestic animals, cattle, pig, horse, sheep, dog, cat and wild animals. *C. parvum* may transmit via fecal-oral route or by contaminated water. Contamination of water with human or animal feces causes epidemics of water origin (29).

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Recent studies revealed 2 genotypes of *Cryptosporidium*. Genotype 1 is considered as the 'human type' and reported to have a role only in human infections. Transmission to other animals failed in studies conducted with varying animals, except to gnotobiotic pigs. Genotype 2 is regarded as 'cattle type'. However, Genotype 2 may also be found in hosts other than cattle including sheep, goat, pig and human.

Balantidium coli is the only ciliated protozoon capable of causing disease in humans. Pigs are the reservoir for human infection. Ingestion of *B.coli* cysts from pig feces through water and food intake results in transmission (14).

Ascaris suum is a nematode found in pigs. However, cases with larva migrans and eosinophilic pneumonia have been reported in humans (29). In some molecular studies carried out in some regions on human intestines, *Ascaris suum* infections spread by pigs were determined to be existent/prevalent. In a study conducted in Denmark, Ascaris infections transmitted from domesticated pigs were determined through PCR-RFLP studies. Thus Ascariasis was noted to be a zoonotic disease (24, 45).

In the light of this background data, we aimed to identify the parasites capable of infecting humans from the feces samples of pigs of a Corlu, Tekirdağ and Istanbul pig farm.

MATERIALS AND METHODS

In our survey total of 238 pig faces samples , 105 of which belong to pigs younger than 6 months ; 133 of which belong to pigs older than 6 months and all of which were collected from the pig farms in Çorlu (Tekirdağ), Ayazma, Arnavutköy (İstanbul) in the summer. 200 grams of fresh samples of faeces from pigs living in sections, 20 and 50 were collected in disposable containers. Studies were done on the day of collecting the materials.

Feces samples were examined by concentration with formol-ether method. Preparations were placed between slide and cover glass and examined under microscope. In addition, preparations obtained by concentration method were also stained by using modified acid-fast staining method and *Cryptosporidium* oocyst were investigated (14). Fisher's Exact test was used for statistical analysis.

RESULTS

Feces samples from a total of 238 pigs were collected at the pig farms located in Çorlu and Istanbul district during summer season. Particularly, intestinal parasites bearing a clinical importance for human beings were investigated. Overall, in 21 samples (8.8%) *Cryptosporidium* spp., in 9(3.7%) *Giardia* spp, in 4(1.6%) *Balantidium coli* cysts and in 9(4.1%) *Ascaris suum* eggs were found.

Among pigs younger than six months (n=105), in 8 samples (7.6%) *Giardia* spp, in 12 (11.4%) *Cryptosporidium* spp., in two *Balantidium coli* cysts and in 9 (6.7%) *Ascaris suum* eggs were identified. Among pigs older than six months (n=133), in one sample (0.7%) *G. lamblia,* in 9 (6.7%) *Cryptosporidium* spp., in 2 (1.5%) *Balantidium coli* cysts and in 9 (4.1%) *Ascaris suum* eggs were identified.

Giardia spp. was significantly more common among baby pigs (<6 months age) (p=0.01), whereas *Ascaris suum* was significantly more common among older pigs (p=0.005).

Our results demonstrate that pigs are a source for intestinal parasites that are also human pathogens. Distribution of intestinal parasites identified in a total of 238 pigs (105 < 6 months, 133 > 6 months age) that are also of clinical importance for human beings are shown in Table 1.

Table 1. Prevalence of parasites capable of infecting humans in pig feces

Age (n=238)	*Cryptosporidium* spp.		*G. lamblia*		*B. coli*		*A. suum*	
	n	%	n	%	n	%	n	%
< 6 mo (n=105)	12	11.4	8	7.6	2	1.9	-	-
> 6 mo (n=133)	9	6.7	1	0.7	2	1.5	9	6.7
All ages	21	8.8	9	3.7	4	1.6	9	3.7

DISCUSSION

Although there are limited numbers of pig farms in Turkey, the number of pigs breed in Turkish farms is 4399 for the year 2005. The present study investigated the presence of parasites particularly bearing a potential to infect humans in the feces of pigs raised in pig farms of Corlu, Istanbul district. A study conducted in the United States reported the prevalence range of *G. duodenalis* and *Cryptosporidium* spp. as 7-69% and 5-100%, respectively (28). Again in another United States study, *C. parvum* oocyst were found among 11.2 % of 62 pigs younger than eight months of age and among 3.1 % of 159 pigs older than nine months; *Giardia* spp. cysts however were found among 6.4% of baby pigs and 8.1% of pigs older than nine months of age. The same study found an overall prevalence of 5.4% and 7.6% for *C.parvum* and *Giardia* spp., respectively among a total of 221 pigs (3). A study from Canada reported a 9% prevalence of *Giardia* spp and 11% prevalence of *C.parvum* among 286 pigs (27). Other reported prevalence figures for *C.parvum* among pigs from different parts of the world are as follows: 1.4% for Germany, 21.9% for Spain, 33.2% for Japan, 9.7% for Canada and 7.1% for the United States (15). Our study found *Giardia* spp. cysts among 3.7% and *C. parvum* oocyst among 8.8% of pigs, and in line with the results of the American study, *C.parvum* prevalence was 11.7% and 6.7% for young pigs and for pigs older than six months of age, respectively with a statistically significant difference. Our prevalence results for *Giardia* spp. are in contrast with the American study with 7.6% prevalence for young pigs and a much lower prevalence for older pigs (0.7%). As reported by several investigators, this may be due to the intermittent cyst discharge (28). A study from Ontorio reported the

presence of *Cryptosporidium* oocyst among 25% of pig feces samples (34). Yu *et al*. found *Cryptosporidium parvum* oocyst in 10.5% of feces samples from 589 pigs (44). Although the number of subjects is smaller in our study (n=238 vs. 589), the frequency of *Cryptosporidium* was similar (8.8%). Besides genotype 1 and 2 of *Cryptosporidium* with a known role in human infections, infections with other genotypes found in animals and considered host specific have also been reported.

Three human infections have been reported with the dog specific genotype of *Cryptosporidium.* One of these patients was HIV positive and the remaining two were children (32, 33, 42). Human infections with *C. felis* (found in cats), *C. meleagridis* (birds), *C. muris* (rodents), corvine genotype (deer) and pig genotype have also been reported (19, 21, 32 33, 41). Our findings suggest that genotyping of *Cryptosporidium spp*. isolated from Turkish population will provide information on animal reservoirs.

Balantidium coli is the only ciliated protozoon capable of infecting humans. Its prevalence among pigs has been reported as 47.2% in China, 25% in Iran (among wild boars), 33.3% in Venezuela and 55.1% in United States (12, 22, 36, 39). In a study from Denmark, prevalence of *B. coli* found to increase from 57% to 100% by increasing age (from 4 to 52 months) (16). *B. coli* prevalence was 1.6% in the present study. *B. coli* cysts were found in 4 of 238 feces samples (2 of them < 6 months of age). *B. coli* prevalence in the present study is much lower compared to other studies. Most of the pigs older than six months of age were not older than 1 years of age. This may account for the low *B. coli* prevalence.

Following figures have been reported for *Ascaris suum* prevalence among pigs: 3.60/7.70% in Czech Republic, 44.3% in Tanzania, 13% from in Denmark (13% among baby pigs recently ceased breastfeeding) and 2% in Spain (among wild boars) (7, 11, 23, 25).

A. suum prevalence was 4.1% in the present study and this figure is in line with the results of previous studies. However, higher frequencies have also been reported from different parts of the world (44.3% in Tanzania, 54.5% in Botswana, 36.7% in China) (5, 26). Approximately 50% to 70% of pigs are estimated to be infected by *A.suum* in the world (29). Following the ingestion of food and water contaminated by *A. suum* eggs by humans and other mammalians, larvae reach liver and lung alveoli via blood stream resulting in eosinophilic pneumonia, liver lesions, myelitis and visceral larva migrans characterized by neurological symptoms including encephalo-myelo-radiculo-neuropathy (43, 35, 17).

However, the evolution is complete in humans. Therefore, *A.suum* is among the causes of visceral larva migrans in humans. Human cases with liver and lung lesions, cases and epidemics of eosinophilic pneumonia have been reported and *A.suum* specific antibodies were positive in all these cases (2, 18, 20, 35, 37).

Four main types of parasites having the risk of spreading to human were detected in pig faeces. The prevalence of these parasites in human in our country for *G.lamblia* is 0.8%-54.8% (8, 9, 10, 13), in cases with diarrhea for *Cryptosporidium* 3.5%-20%, in cases of which the immune systems are suppressed 18.8%-38.8% (1, 4).

In recent years, the prevalence of *A. lumbricoides* in humans is noted to be decreasing, as 1%-49% in different geographical regions (13, 38). Balantidiosis was not seen in epidemiological studies conducted in our country about researching on parasitic diseases (31).

Our results demonstrate that pig feces are an important source for a group of parasites capable of infecting human beings. A further study is planned to identify the genotypes of *Giardia* spp and *Cryptosporidium* isolates obtained in this study.

REFERENCES

1. **Akyon Y, Ergüven S, Arıkan S, Yurdakök K, Günalp A**, 1999. *Cryptosporidium parvum* prevalence in a group of Turkish children. *Turk J Pediatr*, 41(2): 189-196.
2. **Arimura Y, Mukae H, Yanagi S, Sano A, Matsumoto K, Ihiboshi H, Matsumoto N, Shiomi K, Matsukura S, Matsuzaki Y**, 2001. Two cases visceral larva migrans due to *Ascaris suum* showing a migratory nodular shadow. *Nihon Kokyuki Gakkai Zasshi*, 39: 716-720.
3. **Atwill ER, Sweitzer RA, Pereira MG, Gardner IA, Van Vuren D, Boyce WM**, 1997. Prevalence and risk factors for shedding *Cryptosporidium parvum* oocysts and *Giardia* cysts within feral pig populations in California. *Appl Environ Microbiol*, 63: 3946-3949.
4. **Aydın F, Katırcıoğlu İ, Köseahmet F, Bakır T, Bingöl R**, 1995. Kronik diyareli hastaların dışkı örneklerinde Kriptosporidiumun belirlenmesi. *İnfeksiyon Derg*, 9(1-2): 151-155. (Turkish)
5. **Boes J, Willingham AL 3rd, Fuhui S, Xuguang H, Eriksen L, Nansen P, Stewart TB**, 2000. Prevalence and distribution of pig helminths in the Dongting Lake Region (Human Province) of the people's republic of China. *J Helminthol*, 74:45-52.
6. **Buret A, den Hollander N, Wallis PM, Befus D, Olson ME**, 1990**.** Zoonotic potential of giardiasis in domestic ruminants. *J Infect Dis*, 162: 231-238.
7. **Carstensen L, Vaarst M, Roepstorff A**, 2002. Helminth infections in Danish organic swine herds. *Vet Parasitol*, 106: 253-264.
8. **Çelik T, Atambay M, Daldal N**, 2003. Distribution of Intestinal Protozoa in Diarrheic Cases in Malatya. *Türkiye Parazitol Derg*, 27 (2): 129-132. (Turkish)
9. **Çıragil P, Aral M, Ekerbiçer HÇ, Gül M**, 2003. The Distribution of Intestinal Parasites in Patients Applying to the Microbiology Laboratory of the Sutcu Imam University Medical Faculty. *Türkiye Parazitol Derg*, 27(2): 136-138. (Turkish)
10. **Daldal N, Atambay M, Çelik T**, 2002. İshalli olgularda bağırsak protozoonlarının tanısında Nativ-Lugol ve Trikrom boyama yöntemlerinin karşılaştırılması. *İnönü Üniversitesi Tıp Fakültesi Dergisi*, 9 (3): 175-78. (Turkish)
11. **De-Le-Muela N, Hernandez-De-Lujan S, Ferre I**, 2001**.** Helminths of wild boar in Spain. *Wild Dis*, 37: 840-843.

12. **Devera R, Requena I, Velasquez V, Castillo H, Guevara R, De Sousa M, Marin C, Silva M**, 1999. Balantidiasis in a rural community from Bolivar State, Venezuela. *Bol Chil Parasitol*, 54: 7-12.
13. **Direkel Ş. Özerol İ H, Bayraktar MR**, 2002. Distribution of Intestinal Parasites in the Urban Centre of Malatya. *Türkiye Parazitol Derg*, 26 (1): 52-55. (Turkish)
14. **Garcia LS, Brunckner DA**, 1993**.** *Diagnostic Medical Parasitology*. Second edition. ASM, Washington, D.C. p.49.
15. **Gueselle NJ, Apelbee AJ, Olson ME**, 2003. Biology of *Cryptosporidium parvum* in pigs: from weaning to market. *Vet Parasitol*, 113: 7-18.
16. **Hindsbo O, Nielsen CV, Anderssen J, Willingham AL, Bendixen M, Nielsen MA, Nielsen NO**, 2000. Age-dependent occurrence of the intestinal ciliate *Balantidium coli* in pigs at a Danish research farm. *Acta Vet Scand*, 41: 79-83.
17. **Inatomi Y, Murakami T, Tokunaga M, Ishiwata K, NawaY, Uchino M**, 1999. Encephalopathy caused by visceral larva migrans due to *Ascaris suum*. *J Neurol Sci*, 1;164:195-9.
18. **Kakihara D, Yoshimitsu K, Ishigami K, Irie H, Aibe H, Tajima T, Shinozaki K, Nishie A, Nakayama T, Hayashida K, Nakamuta M, Nawata H, Honda H**, 2004**.** Liver lesions of visceral larva migrans due to *Ascaris suum* infection: CT findings. *Abdom Imaging*, 29: 598-602.
19. **Katsumata T, Hosea D, Ranuh IG, Uga S, Yonagi T, Kohno S**, 2000**.** Short Report: possible *Cryptosporidium muris* infection in humans. *Am J Trop Med Hyg*, 62: 70-72.
20. **Maruyama H, Nawa Y, Noda S, Mimori T, Choi WY**, 1996. An outbreak of visceral larva migrans due to *Ascaris suum* in Kyushu, Japan. *Lancet*, 347: 1766-1767.
21. **Morgan U, Weber R, Xiao L, Sulaiman I, Thompson RC, Ndiritu W, Lal A, More A, Deplazes P**, 2000. Molecular characterization of *Cryptosporidium* isolates obtained from human immunondeficiency virus-infected individuals living in Switzerland, Kenya and United States. *J Clin Microbiol*, 38: 1180-1183.
22. **Morris RG, Jordan HE, Luce WG, Coburn TC, Maxwell CV**, 1984**.** Prevalence of gastrointestinal parasitism in Oklahoma swine. *Am Vet Res*, 45: 2421-2423.
23. **Napravnik J, Berka T**, 2002. Cause and effect of ascariosis in pig herds. *Helminthologia*, 39: 171-183.
24. **Nejsum P, Parker ED Jr., Frydenberg J, Roepstorff A, Boes J, Haque R, Astrup I, Prag J, Sørensen UBS**, 2005. Ascariasis is a zoonosis in Denmark. *J Clin Microbiol*, 43(3): 1142-1148.
25. **Ngowi HA, Kassuku AA, Maeda GE, Boa ME, Willingham AL**, 2004. A slaughter slab survey for extra-intestinal porchine helminth infections in northern Tanzania. *Trop Anim Health Prod*, 36:335-340.
26. **Nsoso SJ, Mosala KP, Ndebele RT, Ramabu SS**, 2000. The prevalence of internal and external parasites in pigs of different ages and sexes in Southeast District, Bostwana. *Onderstepoort J Vet Res*, 67: 217-220.
27. **Olsen ME, Thorlakson CL, Deselliers L, Morck DW, Mcallister TA**, 1997. *Giardia* and *Cryptosporidium* in Canadian farm animals. *Vet Parasitol*, 68: 375-381.
28. **Olson ME**, 2002. *Cryptosporidium* and *Giardia*. Emerging Zoonoses, p.24-30.
29. **Olson ME, Guselle N**, 2000**.** Are pig parasites a human health risk? *Adv Pork Production*, 11: 153-162.
30. **Olson ME, McAllister TA, Deselliers L, Morck DW, Cheng KJ, B AG, Ceri H**, 1995. The effect of giardiasis on production in a domestic ruminant (lamb) model. *Am J Vet Res*, 56: 1470-1475.
31. **Özcel MA**, 2007. Balantidiosis. Özbel Y, Ak M. eds. Özcel'in Tıbbi Parazit Hastalıkları. İzmir: Meta Basım. p.423-428. (Turkish)
32. **Pedraza-Diaz S, Amar C, McLauchlin J**, 2000**.** The identification and characterisation of an unusual genotype of Cryptosporidium from human faeces as Cryptosporidium meleagridis. *FEMS Microbiol Lett*, 189: 189-194.
33. **Pieniazek NJ, Bornay-Llinares FJ, Slemenda SB, Da Silva AJ, Moura IN, Arrowood MJ, Ditrich O, Addiss DG**, 1999. New Cryptosporidium genotypes in HIV- infected persons. *Emerg Infect Dis*, 5: 444-449.
34. Ron fleming: http://www.omafia.gov.on.ca/english/engineer/facts/04-015.htm.
35. **Sakakibara A, Baba K, Niwa S, Yagı T, Wakayama H, Yoshida K, Kobayashi T, Yokoi T, Hara K, Itoh M, Kimura E**, 2002.Visceral larva migrans due to Ascaris suum which presented with eosinophilic pneumonia and multiple intra-hepatic lesions with severe eosinophil infiltration-outbreak in a Japanese area other than Kyushu. *Intern Med*, 1: 574-579.
36. **Solaymani-Mohammadi S, Rezaian M, Hooshyar H, Mowlavi GR, Babaei Z, Anwar MA**, 2004**.** Intestinal protozoa in wild boars (Sus scrofa) in western Iran. *J Wildl Dis*, 40: 801-804.
37. **Tokojima M, Ashitani J, Nakazato M**, 2004. A case of eosinophilic pneumonia caused by visceral larva migrans due to *Ascaris suum. Kansenshogaku Zasshi*, 78: 1036-1040.
38. **Unat EK, Akaslan S, Midilli K, Kaymaz H, Şahin R, Ak M, Ergin S, Kaya S**, 1989. Şanlıurfa' da dört okulda öğrenci dışkılarının parazitoloji açısından incelenmesi sonuçları. *Türkiye Parazitol Derg*, 13(3): 75-80. (Turkish)
39. **Weng YB, Hu YJ, Li Y, Li BS, Lin RQ, Xie DH, Gasser RB, Zhu XQ**, 2005. Survey of intestinal parasites in pigs from intensive farms in Guandong province, Peoples Republic of China. *Vet Parasitol*, 127(3-4): 333-336.
40. **Wolfe MS**, 1992. Giardiasis. *Clin Microbiol Rev*, 5: 93-100.
41. **Xiao L, Bern C, Arrowood M, Sulaiman I, Zhau L, Kawai V, Vivar A, Lal AA, Gilman RH**, 2002**.** Identification of the *Cryptosporidium* pig genotype in a human patient. *J Infect Dis*, 185: 1846-1848.
42. **Xiao L, Bern C, Limor J, Sulaiman I, Roberts J, Checkyley W, Cabrera L, Gilman RH, Lal AA**, 2001. Identification of 5 types of *Cryptosporidium* parasites in children in Lima, Peru. *J Infect Dis*, 183: 492-497.
43. **Yoshida S, Matsui M, Wang HY, Oeda T, Sasaki T, Komure O, Ozawa K, Konisi T, Saida T, Yoshikawa H, Nawa Y**, 2004. A case of myeloradiculitis as a complication of visceral larva migrans due to *Ascaris suum*. *Rinsho Shinkeigaku*, 44: 198-202.
44. **Yu JR, Seo M**, 2004**.** Infection status of pigs with *Cryptosporidium parvum*. *Korean J Parasitol*, 42: 45-47.
45. **Zhu X, Gasser RB, Jacobs DE, Hung GC, Chilton NB**, 2000. Relationship among some ascaridoid neamtodes based on ribosomal DNA squence data. *Parazitol Res*, 86(9):738-744.