Journal of Microbiology, Immunology and Infection (2014) 47, 70–74

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ORIGINAL ARTICLE

Investigation of gastrointestinal parasites of dairy cattle around Taiwan

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Received 20 January 2012; received in revised form 16 March 2012; accepted 24 March 2012

KEYWORDS
Dairy cattle;
Gastrointestinal parasites;
Prevalence;
Taiwan

Background: Parasitic nematodes are one of the most important causes of production losses in most cattle-producing countries of the world. The aim of the present study is to make a through estimate of helminth and protozoan infection prevalence in dairy cattle around Taiwan.
Methods: Coprological techniques, including direct fecal smear, simple flotation, and simple sedimentation, were used to detect gastrointestinal helminths and protozoan in dairy cattle. A total of 1259 rectal fecal samples were collected from Holstein dairy cattle at 94 farms in 13 counties in Taiwan.
Results: The overall prevalence of gastrointestinal parasitic infection was 86.9%. The infection rates of protozoa, nematodes, trematodes, and cestodes were 81.3%, 7.9%, 1.6%, and 0.6%, respectively. Among all parasites, *Buxtonella sulcata* (61.7%) was the most predominant one, followed with *Cryptosporidium* spp. (32.6%) and *Eimeria* spp. (11.8%). There were significant differences in the prevalence of protozoa and nematodes between different age groups and distributional area groups.
Conclusion: The present study demonstrated that gastrointestinal parasitic infections occur frequently in dairy cattle around Taiwan, especially protozoan infections. The results indicated that a superior management system and regular anthelmintic treatment should be used for the control of parasitic infections in dairy cattle farms.

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1684-1182/$36
http://dx.doi.org/10.1016/j.jmii.2012.10.004

Introduction

Throughout Southeast Asia, infections caused by gastrointestinal parasites are prevalent in cattle because of the suitable climate for the transmission of infection.[1−3] Parasitic nematodes are one of the most important causes of production losses in most cattle-producing countries of the world. Losses may involve mortality, reduction in weight gain, retarded growth, and low fertility.[4,5] In raising livestock for food production, studies that help in quantifying the economic losses caused by parasitism are important, especially in smallholder farming systems in developing countries.[6] As parasites may cause clinical and nonclinical diseases leading to economic losses, the goal of veterinarians and producers is to prevent parasitism through management, nutrition, epidemiology, and effective treatment.[7]

Researchers have carried out several regional studies in Taiwan; however, the results are outdated and limited.[8−11] Therefore, the aim of the present study is to make a through estimate of helminth and protozoan infection prevalence in dairy cattle around Taiwan.

Materials and methods

Sample population

A total of 1259 rectal fecal samples of Holstein dairy cattle were collected from various counties of Taiwan (Table 1). The fecal samples were kept at 4°C and taken to the laboratory for parasitic examination. The age of the cattle was categorized as calves (less than 1 year old), heifers (1−2 years old), and cows (more than 2 years old).

Fecal examinations

Fecal samples were examined for the presence of helminth ova, protozoan cysts and oocysts, employing the simple floatation procedure using saturated NaCl. A simple sedimentation process was used to detect the eggs of flukes and some other tapeworms and nematodes, whose eggs do not float readily in saturated sodium chloride solution.[12] Direct fecal smears were performed to examine the presence of protozoan trophozoites.

Moreover, in order to detect the oocysts of Cryptosporidium, two smears were prepared from each fecal sample and stained using the modified Ziehl-Neelsen method.[13] The stained fecal smears were observed microscopically under oil immersion at 1000× magnification.

Table 1 Geographical distribution of fecal sample collection

Geographical area	Number of samples
Northern area	218
Taipei County	90
Taoyuan County	90
Miaoli County	58
Central area	467
Taichung County	211
Changhua County	86
Yunlin County	142
Nantou County	28
Southern area	427
Chiayi County	73
Tainan County	86
Kaohsiung County	90
Pingtung County	178
Eastern area	127
Hualien County	60
Taitung County	67
Total	1259

Statistics

The Chi-square test was used to compare the differences between the groups. Probability values below 0.05 were considered significant. The odds ratio was used to assess the risk of endoparasitic infections in different age groups and areas.

Results

A total of 1259 rectal fecal samples, including 364 calves (less than 1 year old), 420 heifers (1−2 years old), and 475 cows (more than 2 years old), were collected from around Taiwan. Of the 1259 fecal samples collected, the overall prevalence of gastrointestinal parasitic infection was 86.9%. The double-, triple-, and multi-infection rates were 42.7%, 14.9%, and 4.8%, respectively. The highest prevalence was protozoan infection (81.3%), followed by nematodes (7.9%), cestodes (1.6%), and trematodes (0.6%).

This investigation detected three types of protozoa trophozoites or cysts/oocysts in the feces, including *Buxtonella sulcata* (61.7%), *Cryptosporidium* spp. (32.6%), and *Eimeria* spp. (11.8%). The rising prevalence of *B. sulcata* correlated with an increase in age. The infection rate of *Eimeria* spp. in calves and heifers (14.8% and 16.9%) was significantly higher than that in cows (5.1%). Identified nematode eggs from fecal samples in the present study included Strongyle nematode, *Trichuris globulosa*, *Strongyloides papillosus*, and *Capillaria bovis*. Strongyle nematode (5.8%) was the most dominant species found in Holstein cattle, and the prevalence in East Taiwan was significantly higher than those in other areas. *Trichuris globulosa* infected 33 cattle (2.6%), primarily calves and heifers. The infection rate was significantly higher in East Taiwan than those in other areas (Table 2).

The prevalence of cestodes (1.6%) was relatively lower than that of other parasites. Among the infected cattle, *Moniezia benedeni* infected 18 cattle (1.4%). In addition, *Hymenolepis diminuta* infected two cattle (0.2%). There was no apparent variation between different ages of dairy cattle; however, the infection rates in northern and eastern areas were significantly higher than those in the middle and southern areas.

Trematodes infected only eight cattle (0.6%). The study found the eggs of *Eurytrema pancreaticum*, *Fasciola* spp., and *Paramphistomum* spp. from feces. There were significant differences in the infection rates of protozoa and nematodes between different age groups and distributional area groups (Table 3).

Table 2 Prevalence of gastrointestinal parasites in Holstein dairy cattle ($N = 1259$) in Taiwan

Species of parasites	Prevalence % (No.[a])	Different age groups				Different areas				
		Calf ($n = 364$)	Heifer ($n = 420$)	Cow ($n = 475$)	p-value	North ($n = 238$)	Central ($n = 467$)	South ($n = 427$)	East ($n = 127$)	p-value
Protozoa	81.3 (1023)	70.9 (258)	85.0 (357)	85.9 (408)		87.8 (209)	73.9 (345)	86.2 (368)	79.5 (101)	
Buxtonella sulcata	61.7 (777)	41.5 (151)	65.2 (274)	74.1 (352)	<0.001	69.7 (166)	51.4 (240)	69.6 (297)	58.3 (74)	<0.001
Cryptosporidium spp.	32.6 (410)	33.8 (123)	27.9 (117)	35.8 (170)	<0.05	35.3 (84)	27.0 (126)	37.7 (161)	30.7 (39)	<0.01
Eimeria spp.	11.8 (149)	14.8 (54)	16.9 (71)	5.1 (24)	<0.001	13.9 (33)	13.5 (63)	5.6 (24)	22.8 (29)	<0.001
Nematodes	7.9 (100)	11.0 (40)	10.5 (44)	3.4 (16)		6.7 (16)	6.0 (28)	6.1 (26)	23.6 (30)	
Capillaria bovis	0.2 (2)	0.3 (1)	0.2 (1)	0.0 (0)	0.54	0.4 (1)	0.2 (1)	0.0 (0)	0.0 (0)	0.57
Strongyle nematodes	5.8 (73)	6.0 (22)	8.3 (35)	3.4 (16)	<0.01	6.7 (16)	4.7 (22)	2.8 (12)	18.3 (23)	<0.001
Strongyloides papillosus	0.4 (5)	0.8 (3)	0.2 (1)	0.2 (1)	0.30	0.0 (0)	0.6 (3)	0.2 (1)	0.8 (1)	0.49
Trichuris globulosa	2.6 (33)	5.5 (20)	3.1 (13)	0.0 (0)	<0.001	0.0 (0)	1.7 (8)	3.3 (14)	8.7 (11)	<0.001
Cestodes	1.6 (20)	2.2 (8)	1.4 (6)	1.3 (6)		2.9 (7)	1.3 (6)	0.7 (3)	3.1 (4)	
Hymenolepis diminuta	0.2 (2)	0.5 (2)	0.0 (0)	0.0 (0)	0.09	0.0 (0)	0.4 (2)	0.0 (0)	0.0 (0)	0.33
Moniezia benedeni	1.4 (18)	1.6 (6)	1.6 (4)	1.4 (6)	0.90	2.9 (7)	0.9 (4)	0.7 (3)	3.1 (4)	<0.05
Trematodes	0.6 (8)	0.3 (1)	0.2 (1)	1.3 (6)		2.5 (6)	0.2 (1)	0.1 (2)	0.0 (0)	
Eurytrema pancreaticum	0.1 (1)	0.0 (0)	0.0 (0)	0.2 (1)	0.44	0.4 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.23
Fasciola spp.	0.2 (3)	0.3 (1)	0.0 (0)	0.4 (2)	0.43	0.8 (2)	0.0 (0)	0.2 (1)	0.0 (0)	0.17
Paramphistomum spp.	0.3 (4)	0.0 (0)	0.2 (1)	0.6 (3)	0.26	1.3 (3)	0.2 (1)	0.0 (0)	0.0 (0)	<0.05

[a] No. = number of infected cattle.

Discussion

Gastrointestinal nematode infections of cattle remain a constraint on the efficient raising of cattle throughout the world. In less developed agricultural systems, parasitic infections may cause severe clinical signs, such as stunted growth, tissue edema, and diarrhea.[14] Even in well-managed herds with no signs of clinical parasitism, the presence of gastrointestinal parasites hinder the growth in young animals[15] and decrease milk production in adult cows.[16] In Southeast Asia, infections caused by gastrointestinal parasites are prevalent in cattle because of the convenient climate for the transmission of infection.[2]

The results of the present study indicated a high prevalence of protozoan infection in dairy cattle. The different management of dairy cattle in Taiwan might cause the high prevalence of protozoa infection. The climate in the temperate zone is suitable for rearing Hostein dairy cattle, but Taiwan is in a sub-tropic region with a hot and humid climate. High temperatures may decrease milk production. Therefore, herdsmen often sprinkle cattle with water to decrease their body temperature. However, this action

Table 3 Risk factor analysis for endoparasites in different areas and age groups

Factor	Protozoa		Trematodes		Cestodes		Nematodes	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Area								
North area	—	$p < 0.001$	—	$p < 0.01$	—	$p = 0.06$	—	$p < 0.001$
Central area	0.39 (0.25—0.61)		0.08 (0.01—0.69)		0.43 (0.14—1.29)		0.89 (0.47—1.67)	
South area	0.87 (0.54—1.39)		0.09 (0.01—0.76)		0.23 (0.06—0.91)		0.90 (0.47—1.71)	
East area	0.54 (0.30—0.96)		—		1.07 (0.30—3.74)		4.29 (2.24—8.24)	
Age								
Calf	—	$p < 0.001$	—	$p = 0.09$	—	$p = 0.53$	—	$p < 0.001$
Heifer	2.33 (1.64—3.31)		0.87 (0.05—13.90)		0.65 (0.22—1.88)		0.95 (0.60—1.49)	
Cow	2.50 (1.78—3.53)		4.64 (0.56—38.74)		0.57 (0.20—1.66)		0.28 (0.16—0.51)	

O.R. = odds ratio; C.I = confidence interval.

creates a moist environment that facilitates the development and transmission of protozoa.[17]

In the present study, *B. sulcata* infection was found in 61.7% of the entire dairy cattle population, and the rising prevalence correlated with the increasing age. This finding was similar to the results of a previous investigation.[11] Fox and Jacobs indicated that the amount of carbohydrate in the diet would influence the population growth or decline of *B. sulcata*.[18] Feeding adult cattle with a considerable quantity of corn and wheat bran to recruit the nutritional loss during lactation might reduce the prevalence of *B. sulcata* infection in adult cattle.

Cryptosporidium spp. infection was the second most predominant protozoan infection in dairy cattle. There was no significant difference in infection between different age groups in the present study. However, Roy et al reported calves to be most vulnerable to infection and they also act as reservoirs.[19] The infection is transmitted by direct fecal-oral transmission or through water and food contaminated with *Cryptosporidium* oocysts, with as few as 10 viable oocysts needed for infection.[20] A high level of *Cryptosporidium* shedding calves in a herd was associated with an increased risk of diarrhea.[21,22] Wu et al concluded that *Cryptosporidium parvum* infection plays an important pathogenic role in neonatal calf diarrhea syndrome in southern Taiwan.[23] In farm animals, *Cryptosporidium* infections lead to poor health and significant economic loss.[24] The fact that *Cryptosporidium* was found to infect humans,[20,25] as well as the association of *Cryptosporidium* with waterborne outbreaks of diarrhea in humans,[26] has certainly given the parasite widespread recognition. Therefore, the importance of *Cryptosporidium* spp. in public health should be concerned.

Surprisingly, nematodes infected only 7.9% of dairy cattle. The infection rate was significantly lower than that obtained in a previous study carried out by Wang.[11] In the present study, the prevalence of nematodes in eastern Taiwan was significantly higher than those in other areas. Although regular anthelmintic treatment of mass-raised cattle could easily control nematode infection, nematodes still infected a few of dairy cattle. This result may be due to uncertain anthelmintic administration, poor management, or the circumvention of immune responses.

The prevalence of *M. benedeni* was low in dairy cattle. The low proportion of calves infected could be due to little exposure to the intermediate hosts, the free-living soil mites on the pasture.[27] The eggs of *Hymenolepis diminuta* were found in the feces of two Holstein calves. Since the natural hosts of *H. diminuta* are rats, if the forage was contaminated with rodent feces, it might have resulted in the presence of *H. diminuta* eggs in cattle feces. This tapeworm is commonly found in areas where large amounts of grain or other dry food products that are consumed by rats are stored.[28] Tung et al reported that 38.9% of the rodents and shrews caught on farms were infected with *H. diminuta*.[29] *H. diminuta* can accidentally infect humans, causing diarrhea and abdominal pain in the case of serious infection.[30–32] Transmission of these zoonotic parasites to humans is more frequent in areas with high temperatures and poor sanitary conditions.[33]

Chang and Wang indicated that *Fasciola hepatica* infected more than 30% of cattle in southern Taiwan.[8] However, the infection rate of this trematode was only 0.6% in the present study, and *Fasciola* spp. had infected only three cattle. Increase in environmental pollution considerably decreases the number of intermediate hosts, thereby significantly reducing the prevalence of trematodes. Although the infected number was limited, the risk of trematode infection was higher in northern Taiwan than that in other areas. This may be due to some northern Taiwan farmers occasionally feeding fresh grass to their cattle. If metacercaria or intermediate hosts were on the grass, this would increase the risk of infection.

Gastrointestinal parasites in cattle remain a serious impediment to the efficient production of milk and meat throughout the world. Climatic conditions determine which parasites will be present in a given region. The nutritional status of the livestock may decide the severity of an individual's infection, which is affected by the parasites acquired from the livestock.[7] The survey of dairy cattle on the basis of fecal examination had provided insight into the current prevalence of gastrointestinal parasites in Taiwan. Dairy farmers should employ improved management systems and regular anthelmintic treatments for controlling parasitic infections.

Conflicts of interest

All contributing authors declare no conflicts of interest.

Acknowledgments

The authors would like to express their sincere thanks to the Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture, Executive Yuan, Taiwan R.O.C. for its financial support.

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