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Species Composition and Status of Abomasal Nematodes of Cattle Slaughtered at Abergelle Export Abattoir, Mekelle, Ethiopia

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Abstract: A cross sectional study was carried out from November 2011 to March 2012 with the objective of determining the species composition and prevalence of abomasal nematode parasites of cattle slaughtered at Abergelle Export Abattoir. A total of 384 abomasums of cattle were collected and examined based on the standard laboratory manual procedures for identification of abomasal nematodes. Out of total examined, 25 (6.15%) animals were found positive. The most predominant abomasal nematode parasites found in the study area were *Trychostrongylus. axei* (2.86%), *Haemonchus placei* (1.82%), *Haemonchus contortus* (1.56%) and mixed infections of *Trychostrongylus axei* and *Haemonchus placei* (0.26%) respectively. The prevalence of the abomasal nematodes in animals with different body condition was studied and revealed higher in poor (21.05%), medium (3.86%) and good (0.99%) body conditioned animals respectively with a significant statistical difference ($P<0.05$). Moreover, the prevalence was higher in adult (8.62%) and relatively lower in older (6.13%) animals. However, the variation in the prevalence among different age groups was not statistically significant ($P>0.05$). Furthermore, higher prevalence was recorded during the rainy season (8.88%). Whereas, lower during the dry season (2.89%). There was not statistically significant variation ($P>0.05$) between different months of the year. In addition, on the bases of origin of the animals, highest prevalence was recorded from shire (8.82%) and lower from Mekelle (3.57%). The variation in the prevalence on the bases of origin was not statistically significant ($P>0.05$). Therefore, the present study showed that abomasal nematodes are important health problems and affecting the productivity of the cattle in the study area and significantly affect the livestock economy.

Key words: Cattle · Abomasum · Species Composition · Abomasal Nematodes · Export Abattoir

NTRODUCTION

The Ethiopian economy is predominantly based on agriculture. This sector accounts for 46% of the gross domestic product. Livestock contributes 33% of the agricultural gross domestic product and 15% to the export earnings and it has a huge contribution to the agricultural productivity [1]. In developing countries, cattle are the most important animals in the farming, as a food source and for skin production [2]. Ethiopia has 49.3 million cattle, 25 million sheep, 21.9 million goats, 1.8 million horses, 5.4 million donkeys, 375, 519 mules, 759, 696 camels, 38.13 million poultry and 5.2 million beehives [3]. Although Ethiopia is known to have the largest livestock production in Africa, the contribution of livestock industry to the national economy is considerably less than its tremendous potential. Some of the constraints that made the livestock sector still marginal are parasite infections [4]. Studies in Ethiopia strongly suggests that helminthiosis in particular abomasal nematodiasis is considered as one of the major setbacks to the livestock productivity incurring huge indirect and direct losses in the country [5].

Cattle populations are of more susceptible to a majority of important parasitic diseases [6]. The main challenge with nematode parasites is due to the fact that

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they are most numerous, complex and variable among the worm parasites of domestic animals [7, 8] and different species of the same genera may infect various regions of the gastrointestinal tracts [9]. This is one of the reasons why gastro intestinal nematodes are recognized as a major constraint to the cattle production in developing countries leading to significant economic losses [10]. Moreover, abomasal nematode infections in the ruminants are of a major importance in many agro-ecological zones in Africa and have the highest index as animal health constraint to the poor keepers of livestock worldwide through losses due to reduced weight gains and growth rate, reduced nutrient utilization, low or meat, milk, wool, skin and hide production, involuntary culling, cost of treatment and animals death mortality [11].

The abomasal nematodes, the Trichostrongylus genera *(T. axei*), it is rarely a primary pathogen in temperate areas, but is usually a component of parasitic gastro enteritis in cattle. By contrast, in subtropics it is one of the most important causes of parasitic gastroenteritis [12]. The other most important genera of abomasal nematode are Haemonchus, which is blood sucking nematode and it may be responsible for extensive losses in cattle, especially in tropical areas [12]. Particularly *Haemonchus contortus* is important and cause severe anemia and death in severely in faceted animals [13] and *Trychostrongylus axei* causes emaciation [14]. Therefore, considering the huge economic loss as a result of those parasites, we aimed at identifying and addressing the real status of the infection and characterization of the species composition in the abattoir.

MATERIALS AND METHODS

Study Area: The study was conducted at Abergelle Export Abattoir, which is found in Mekelle city, the capital city of Tigray Regional State. It is located 783 Km North of Addis Ababa and this zonal town has a mean temperature range of 16.1 to 21.14°C, annual rain fall of 628.8 mm and situated at an altitude of 2000m above sea level. Geographically it is located at 300 32' north latitude and 390 28' east longitudes.

Study Population: The study was conducted on beef cattle slaughtered at Abergelle export abattoir to estimates the prevalence and species composition of abomasal nematodes. The study animals were 384 cattle of different age group which are selected randomly from those entered to the slaughter house. The study was conducted on male animals of local breeds and they are originating from Mekelle. Alamata, Agve and Shire.

Study Design: Cross sectional study, active abattoir survey were used to get information on the disease status and to estimate the prevalence and species composition of the disease and to investigate the main risk factors associated with the disease. Sampling and Sample Size Determination

The total number of cattle required for the study was calculated based on the formula given by Thrusfield [15] using simple random sampling method by taking 95% confidence interval and 50% expected prevalence of abomasal nematodes of cattle in the area.

Anti-Mortem Inspection: During the active abattoir survey, ante mortem inspection was conducted on each randomly selected animal to record each and every observable signs or events. Such as; body condition, age, origin of the animal was recorded.

Post Mortem Examination: A total of 384 abomasums of cattle was collected from the abattoir during the study period. As soon as possible, after the removal of the alimentary tract from the body cavity and the abomasums from the intestine and other parts of the stomach, then the abomasum was taken and ligated at both ends to prevent environmental contamination then transported to the Mekelle Regional Veterinary Laboratory for Necropsy Examination.

Abomasal Worm Recovery, Species Identification and Worm Burdens: The abomasums were opened in longitudinally and the contents were collected and then washed the abomasum wall thoroughly under a stream of water from the tap and rub the mucus membrane of the abomasums carefully with the fingers to remove any worm adhered to it. Then the abomasal contents and mucosal washings were mixed thoroughly and then pour the contents of the bowl and added its washing a little at a time on to a wire mash screen with an aperture of 0.15 mm and then washed with a stream of water from a rubber tube attached to the tap until no more colored matter or food particles passed through. When all the materials has been screened and washed in this way, the screen was inverted over a trough and washed by water. The food material and worms were collected on the screen. And filled the contents of trough up to a volume of 4 liter by adding water and then agitated the whole contents vigorously and the samples were removed using a beaker. The sample of 40 ml was transferred into labeled graduated beaker in 4 steps of 10 ml per step using labeled graduated beaker. Then, small quantities of the 40 ml was placed in to different plastic Petri dishes and diluted with

water. 2-3 ml of iodine for coloration and 2-3ml of sodium thiosulphate were added to each Petri dishes to facilitate easy identification and counting of the worms. The worms were mounted on a glass slide and covered by cover slip then the morphology of the worms was observed under stereomicroscope at 40X. Finally, a total number of worms counted in 40 ml sample was multiplied by 100 to give the number of worms present on the abomasums. The level of worm infection were extrapolated from severity index defined by Hansen and Perry [16] and MAFF [17] in which cattle are said to have light, moderate and heavy nematode infections if their adult worm counts are less than 1-400, 401-1500 and > 1500 for *Haemonchus* species; 1-10, 000, 10, 001-25, 000 and >25, 000 for *Trichostrongylus* species and 1-5000, 5001-10, 000 and >10, 000 for mixed infections respectively. Adult males of abomasal nematodes were identified to species level while the females to generic level based on morphological characteristics.

Data Analysis: All the collected data were analyzed by using SPSS version of 17.0 computer software programs. Descriptive statistics such as chi square (χ^2) test were used to estimate the association between the prevalence of the parasite and the associated risk factors. In all the analysis, confidence level was held at 95% and $P < 0.005$ was set for statistical significant level.

RESULTS

From a total of 384 bovine abomasum samples examined, 25 (6.51%) were revealed an overall prevalence of abomasal nematodes infection. The identified nematode parasites were found to fall in to two different genera and three species with prevalence of 2.86% *Trichostrongylus axei,* 1.82% *Haemonchus placei*, 1.56% *Haemonchus contortus* and 0.26% with mixed infections of *Trichostrongylus axei* and *Haemonchus place*. The most frequently encountered species in this study was the *Trichostrongylus axei* followed by *Haemonchus placei* and *Hacmonchus contortus*. The prevalence of the different species of the abomasal nematodes was studied in relation to different risk factors like body condition, age, origin and month.

The highest prevalence of abomasal nematodes was recorded in poor (21.05%) followed by medium (3.86%) and good (0.99%) body condition score of animals and the highest prevalence was recorded in adults (8.62%) and relatively lower rate was observed in old (6.13%) animals. The prevalence of abomasal nematodes in animals originating from different places was also assessed with the highest prevalence being in animals from shire (8.82%), Agve (7.84%), Alamata (6.86%) and Mekelle (3.57%) respectively. The occurrence rate of the parasites was found the highest in November (8.88%) and lowest rate being observed in February (2.89%) on month basis. However, the study revealed that majority of animals harboring the abomasal nematodes were affected by light to moderate degree of infections.

Moreover, the prevalence of different species of the abomasal nematode in animals with different body condition was studied. Accordingly, higher prevalence was recorded in poor (21.05%), medium (3.86%) and good (0.99%) respectively. The variation in the prevalence of the different species of the abomasal nematodes among animals with different body condition scores was statistically significant ($P < 0.05$) (Table 1).

Furthermore, even if there was not a statistically significant variation ($P > 0.05$) among the different age groups of animals, highest prevalence was recorded in adults (8.62%) and relatively lowers in older (6.13%) age groups of animals (Table 2).

There was not statistically significant variation ($P > 0.05$) between different months of the year. Though it has not statistically associated, higher prevalence of abomasal nematodes was recorded in November (8.88%). Whereas, lower in February (2.89%) on the bases of the month which the animal was examined (Table 3).

In addition, the prevalence of different species of the abomasal nematodes in animals on the bases of origination of different places was also assessed with the highest prevalence rate being in animals from Shire (8.82), whereas lower in Mekelle (3.57%). The variation in the prevalence of the different species of the abomasal nematodes among animals with different in origination was not statically significance association ($P > 0.05$) (Table 4).

DISCUSSION

The present study showed the overall point prevalence of 6.51% bovine abomasal nematodes. The prevalence rate showed in the present study is low comparing to the finding of Sheriff [18] who reported a study in North Gondar with the prevalence of 34.88%. This variation may be due to the difference in geographical and climatic condition and the management system of the area where the animals were originated. The most frequently encountered genus in this study was the *Heomonchus* followed by *Trichostrongylus* and the most predominant abomasal nematode parasite species was the *Trychostrongylus axei* (2.86%) followed

Table 1: Prevalence of abomasal nematodes on body condition bases

		No. of animals positive for each species and their percentage (%)				
Body condition score	N	*T. axei*	*H.placei*	*H.coutortus*	*T.axei* and *T.placei*	Total positive
Poor	76	7(9.21)	5(6.58)	3(3.94)	1(1.31)	16(21.05)
Moderate	207	4(1.93)	2(0.97)	2(0.97)	0(0)	8(3.86)
Good	101	0(0)	0(0)	1(0.99)	0(0)	1(0.99)
Total	384	11(2.8)	7(1.82)	6(1.56)	1(0.26)	25(6.51)

χ^2 value = 36.17, P = <0.001

Table 2: Prevalence of Abomasal Nematodes on age Basis

		No. of positive animals for each species ad their percentage (%)				
Age	Examined animals	*T.axei*	*H.placei*	*H. contortus*	*T.axei* and *H.placei*	Total positive
Adult	58	2(3.44)	2(3.44)	1(1.72)	0(0)	5(8.62)
Old	326	9(2.76)	5(1.53)	5(1.53)	1(0.30)	20(6.13)
Total	384	11(2.86)	7(1.82)	6(1.56)	1(.26)	25(6.51)

χ^2 value = 1.36, p = 0.99

Table 3: Monthly Prevalence of Abomasal Nematodes.

		No. of animals positive for each species and their percentage (%)				
Month	N	*T.axei*	*H.placei*	*H.contortus*	*T.axei* & *H.placei*	Total positive
November	90	4(4.44)	4(4.44)	0(0)	0(0)	8(8.89)
December	107	3(2.80)	1(0.93)	4(3.74)	1(0.93)	9(8.41)
January	85	2(2.35)	2(2.35)	1(1.18)	0(0)	5(5.88)
February	69	1(1.45)	0(0)	1(1.45)	0(0)	2(2.90)
March	33	1(3.03)	0(0)	0(0)	0(0)	1(3.03)
Total	384	11(2.86)	7(1.82)	6(1.56)	1(0.26)	25(6.51)

χ^2 value = 15.38, p = 0.75

Table 4: Prevalence of abomasal nematodes on animal origin basis:

		No.of animals positive for each species and their percentage (%)				
Origin	N	*T.axei*	*H.placei*	*H.contortus*	*T.axei* & *H.placei*	Total positive
Mekelle	112	2(1.78)	1(0.89)	1(0.89)	0(0)	4(3.57)
Ague	102	4(3.92)	2(1.96)	2(1.96)	0(0)	8(7.84)
Alamata	102	1(0.98)	3(2.94)	3(2.94)	0(0)	7(6.86)
Shire	68	4(5.88)	1(1.47)	0(0)	1(1.47)	6(8.82)
Total	384	11(2.86)	7(1.82)	6(1.56)	1(0.26)	25(6.51)

χ^2value = 13.20, p = 0.65

by *Haemonchus placei* (1.82%) and *Haemonchus contortus* (1.56%). This finding contradicts with the previous reports from other geographical region of the world such as Oku *et al.* [19] in Japan which may imply the adaptability of the parasites to the environmental conditions. It may also due to climatic change of Ethiopia, which is a country where extreme temperature and rainfall are experienced and altitude being the most important factor. These could be crucial elements influencing the development and distribution and survival of abomasal nematode parasite. It is also due to the factors which affect the development and survival of the nematodes which are mainly environmental especially climatic change and management practices. In addition, this study showed higher infection rate in adults (8.62%) than in older (6.13%) animals. This showed that the susceptibility and pathogenesity of nematode infections is greater in adults than in old animals. This also could be due to the fact that younger animals are more susceptible than the old counter parts. Because age has an effect on responsiveness or to the development of immunity causing lower worm fecundity in old animals [20, 21]. Old animal may acquire immunity to the parasite through frequent challenge and expel the ingested parasite before they establish infection [22, 23]. However, this finding contradicts with that of Balem *et al.* [24] in Burkinafaso who reported no difference in the level of infestation in cattle of different age groups.

Study on the rate of occurrence of abomasal nematodes showed the highest prevalence rate in animals with poor (21.05%), followed by moderate (3.86%) and good (0.99%) body condition scores. Nutrition may contribute to clinical diseases in adult animals [16] and the well-fed animals can withstand the harmful effects of parasitism and can remain reasonably productive when compared with undernourished animals [25]. The high rate recorded in animals with poor body condition was due to effect of the parasite when occurred in large number causing significant weight loss. The overall prevalence of abomasal nematode infections during the study period was high in November or after rainy season (8.88%) and low in the month February (2.89%). The present study also revealed that majority of animals harboring the abomasal nematodes were affected by light to moderate degree of infections, which showed that abomasal nematodes usually affects the entire regions causing sub-clinically unnoticed economic losses in the area [26]. The environmental factors which influence the pattern of the parasite development are temperature, humidity and rain fall. Hence most of the gastrointestinal nematode diseases are occurred after the rainy season [27]. The fact that high prevalence rate was observed in November could be due to activation of the hypobiotic larvae and it could be due to increased movement of animals in search of feed and water; this increases their chance to get infection. Furthermore, this study also showed the highest prevalence was registered in animals originating from shire (8.82%) and the lowest rate being in animals originating from Mekelle (3.57%). The factors which affect the development and survival of the nematodes are mainly environmental especially climatic change and management practices [28]. This variation in prevalence of bovine abomasal nematodes among animals originating from different places could be linked to difference in the micro-environment which is conducive for the persistence and transmission of the parasite and the standard of management and anthelmentics used in the areas can influence the prevalence of abomasal nematode parasites. In the current study, the observation of mixed infections (0.26%) was very low due to the variation in geographical and climatic conditions, which are appropriate for the parasites and the standard management practices in the areas. *Haemonchus contortus* in cattle gets infection during sharing of the same grazing pasture with sheep flocks under field condition. However, due to the management system of cattle come from isolated feed lot areas, the prevalence was low and *Haemonchus contortus* is the common parasite of sheep and their presence in cattle suggests contact of these animals with sheep grazing areas [11]. Therefore, this study identified the potential risk factors associated with the low to medium prevalence rate of bovine abomasal nematode parasite infections and enabling to design feasible and strategic control of the abomasal nematode parasite of cattle in the study area and other areas of similar ecological features.

CONCLUSION

In conclusion, the result of the present study indicated that abomasal nematodes are one of the major animal health problems in the area which caused major economic losses in the cattle production due to stunted growth, insufficient weight gain, poor feed utilization and mortality and also losses associated with control measures and treatments. However, the attention given to the disease so far has not been sufficient. The most predominant abomasal nematode parasites in cattle in the study area were *Trychostrongylus axei, Haemonchus placei* and *Haemonchus contortus* respectively.

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Competing Interests: We declared that all the authors involved in this study have no any competing interests.

Ethical Standard: The authors would like to inform that no data is taken from human patients related to this study and all the animal subject studies has been conducted in compliance to the university's animal welfare and ethical standards.

REFERENCES

1. Belachew, H., 2004. Livestock Marketing and Animal health in Ethiopia .In; (EVA) (ed.); capacity strengthening / building and partnership for enhanced animal health services provision and development in Ethiopia. Proceedings of the 18th annual conference of the Ethiopian Veternary Association (EVA), held in Addis Ababa, june, 9-10, 2004: pp: 51-72.

2. CSA, Democratic Republic of Ethiopia. Central Statistical Authority, 2003. Agricultural sample survey report on Livestock, Addis Ababa, Ethiopia
3. Getachew, A., 2004. Veterinary education in Ethiopia. In EVA (ed.); capacity strengthening /building and partnership for enhanced animal health services provision and development in Ethiopia. Proceedings of the 18th annual conference of the Ethiopian Veternary Association (EVA), held in Addis Ababa, june, 9-10, 2004: pp: 1-9.
4. Malone, J.B., R. Gomes, J. Hannen, J.M. Yilma, J. Slingenbergh, F. Snijders, O.F. Nachet and E. Atman, 1989. Geographical information system on the potential distribution and abundance of fasciola hepatica and fasciola gigantica in east Africa based on Food and Agriculture Organization database. Vet. Parasitol., 78: 87-88.
5. Abebe, W. and G. Esayas, 2001. Servey on ovine and caprine gastrointestinal helminthosis in Eastern part of Ethiopia during dry season of the year. Revue Vet. Med., 152(5): 379-384.
6. Dwight, D.B., 2003. parasitological for veterinary. 8th ed. Ithaca. Newyork, pp: 153-175.
7. Blood, O.C., O.M. Radiostitis and J.A. Henderson, 1983. Veterinary Medicine; A text book of Diseases of cattle, sheep, pigs, Goats and Horses. 6th ed. London, UK: Bailliere Tindall, pp: 894-944.
8. Kaufmann, J., 1996. Parasitic Infection of Domestic Animals: a diagnostic manual. basel. switzerland: Birkhauser Verlage, pp: 1-54.
9. Jacquiet, P., J.F. Humbert, A.M. Comes, J. Cabaret, A. Thiam and D. Cheikh, 1995. Ecological, Morphological and characterization of sympatric Haemonchus species parasites of Domestic ruminants in Mauritania. Parasit., 110: 483-492.
10. Debela, E., 2002. Epidemiology of gastrointestinal helmenthosis of rift valley goats under traditional husbandly system in Admi Tulu District, Ethiopia. SINE: Ethiopian Journal Science, 25: 35-44.
11. Kumsa, B. and A. Wossene, 2006. Abomasal nematodes of small ruminants of ogaden region, eastern Ethiopia: prevalence, worm burden and species composition. Revue Med. Vet., 157: 27-32.
12. Urquhart, G.M., G. Armour, J.L. Duncan, A.M. Dunn and F.W. Jennings, 2003. Veterinary Parasitology. 2nd ed. London, UK: Black well science Ltd, pp: 3-26.
13. Perry, B.D., T.E. Randolph, J.J. Dermots, K.R. Sones and Thorn, 2002. Investigating in Animal Health Research. ILRI (International Livestock Research Institution). Kenya, pp: 148.
14. Taylor, M.A., R.L. Coop and R.L. Wall, 2007. Veterinary Parasitology. 3rd ed. London: Black Well, pp: 160-161.
15. Thrusfield, M., 2005. Survey in Veterinary Epidemiology. 3rd ed. Oxford, UK: Blackwell Science Ltd, pp: 182-189.
16. Hansen, J. and B. Perry, 1994. The Epidemiology and Control of Helminth Parasites of Raminants. 2nd ed. A hand book. International laboratory for research on animal disease. Nairobi, Kenya: ILRAD., pp: 17-160.
17. MAAF., 1986. Manual of Veterinary Parasitological Laboratory Techniques. Tech. Bull. No. 18, Her Majesty's Stationary Office, London, pp: 1-57.
18. Sheriff, A., 2011. Prevalence of abomasal nematodes of cattle slaughtered at Gondar Elfora Abattoir, North Gondar, Ethiopia. DVM Thesis Gondar, Ethiopia.
19. Oku, Y., M. Nakazawa, S. Hatakeyama, S. Miyaji, Kitaguchi, C. Cabrara-lopez, M. Okamoto, M. Kamiya, M. Ohbayashi and Hong-Kean, 1985. Survey of abomasal and duodenal nematodes in cattle in Hokkaido, Japan.
20. Kloosterman, A., H.W. Ploeger and K. Frankena, 1991. Age resistance in calves to Ostertagia ostertagi and cooperia omcophon. Veterinary Parasitology, 39: 101-103.
21. Ploger, H.W., A. Kloosterman, W. Rietveld, H. Hilderson and W. Hollanders, 1994. Quantitative estimation of the level of exposure to gastrointestinal nematode infection in first-year calves. Veterinary Parasitology, 55: 260-271.
22. Dunn, A.M., 1987. Veterinary Helminthology. 2nd ed. Wiliam Heilemann Medical Books. London, pp: 19-36.
23. Fishes, S.M. and R.R. Say, 1989. Manual of Tropical Veterinary Parasitology. UK, C.A.B International.
24. Balem, A., O. Ouedraogo and R. Bessin, 2000. Gastrointestinal nematodes and cestodes of cattle in Burkinafaso. Burkinafaso. Biotechnol. Agron. Soc. Environ., 5(1): 17-21.
25. Knox, M.R., J.F.J. Torres-Acosta and A.J. Aguilar-caballer, 2006. Exploiting the effect of dietary supplementation of small ruminants on resilience and resistance against gastrointestinal nematodes. Veterinary Parasitology, 52(1): 40-46.

26. Radiostitis, O.M., C.C. Gay, K.W. Hinchcliff and P.D. Constable, 2007. Veterinary Medicine: Atext book of the diseases of cattle, horses, sheep, pigs and goats. 10th ed. Oxford, UK: Elseiver, pp: 1541-1553.
27. Tembly, S., A. Lallou-Kassi, J.E. Rege, D.D. Sovanis, M.L. Hiou and R.L. Baker, 1997. The Epidemiology of nematode infections of sheep in a cool tropical environment. Veterinary Parasitology, 70: 131-136.
28. Urquhart, A.M., J. Armour, A.M. Duncan and F.W. Jenings, 1996. Veterinary Parasitology. Black well science, Scotland, pp: 10-41.