Research Article

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Bovine fascioliosis in Niger state, Nigeria: effects of climatic and elevation factors on its distribution

Abstract

Aim: This study investigated the burdens and the impact of environmental risk factors on the prevalence of bovine Fascioliosis in trade cattle slaughtered in municipal abattoirs in Niger State, Nigeria.

Methodology: Retrospective abattoir surveys were conducted at five municipal abattoirs, which involve the retrieval and analysis of meat inspection data from the abattoirs carried out between January 2004 and December 2014. Records of monthly and annual returns from the abattoirs were scrutinized and used to determine prevalence of *F. gigantica*. A total of 19 bioclimatic variables of present climate and elevation data derived from the SRTM for Nigeria were downloaded from http://www.worldclim.org/ and were used in the prediction of bovine fascioliosis distribution using MaxEnt software version 3.3.3k. Map visualization was performed on DIVA-GIS version 7.5.0.

Results: The mean prevalence of bovine fascioliosis in Niger State, Nigeria is 1.46% over a ten years period. The average prevalence from the five municipal abattoirs; Minna, Suleja, Bida, Kotangora and New Bussa were 1.31, 1.70, 1.12, 1.05 and 1.24% respectively and was not significant difference (P>0.05). The model prediction reveals that Wushishi, Katcha, Gbako, Bosso, parts of Shiroro and Rafi LGAs lies within the high risk areas with probability of occurrence ranging from 0.8 – 1. Precipitation and mean temperature of the coldest quarter, and precipitation of wettest quarter were the environmental variables that favour high prevalence of bovine fascioliosis.

Discussion: The result of this study indicated low prevalence of 1.46% of fascioliosis in cattle in Niger State, Nigeria over the ten years period. The low prevalence might be attributed to the provision of better veterinary services and increase in consultancy services to farmers on livestock management. Conclusion: Bovine fascioliosis is endemic in Niger State Nigeria with little economic importance. The South-Eastern region of the state is at high risk of infection than other regions.

Keywords: Abattoir, Bovine, Fasciolosis, Environmental Variables, Nigeria

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Background

Fascioliosis, also known as liver fluke disease, is a hepatic parasitic infection caused by three trematodes, Fasciola hepatica, Fasciola buski and *Fasciola gigantica*[1] with the definitive hosts range from herbivorous mammals to humans. Fascioliosis is transmitted by fresh water snails Lymnae.[1,2,3] Fascioliosis has the largest geographical widespread of any emerging vector-borne zoonosis, occurring in 51 countries worldwide.[4] It causes significant economic losses to global agriculture, estimated at N3 billion USD annually, through liver condemnation and reduction of milk and meat yields.[5,6] The World Health Organization estimated that 2.4 million people are infected with Fasciola species and a further 180 million are at risk of infection.[7] Fascioliosis gains public concern not only due to its prevalence and economic significance to animal stock in all continents[8,9] but also to its zoonotic aspect. Fasciola are haematophagous, their infection usually results in anaemia[10] and can cause a high proportion of mortalities, especially in small ruminants and calves.[8] Over the last decade there has been a substantial increase in the number of fascioliosis cases recorded. It is spurred on by both environmental changes (warmer, wetter climate) and man-made modifications such as an increase in animal movements and intensification of livestock farming.[1] Studies in Nigeria reported that bulky nature of cattle faeces, high and sufficient moisture content of the soil gives room for larval development and survival which enabled the third larval stage to remain in the fecal droppings in the dry season until the onset of the rains, when they are released and the faeces used as a manure.[11,12] The use of meat inspection to detect disease cases in slaughter facilities is particularly useful in Africa where laboratory capacity for routine disease diagnosis is limited.[13,14] with paucity of empirical information on the burdens and associated predisposing internal (biological) and external (climatic and environmental) factors for Fascioliosis such data are needed to serve as convenient and inexpensive source of information for the development of fascioliosis control programs in Nigeria.[15] This study assess the impact of environmental risk factors on the prevalence of bovine fascioliosis in trade cattle slaughtered in municipal abattoirs in Niger State, Nigeria.

Materials and methods

Study area

The study was conducted in Niger State, North-Central Nigeria located on latitude 8° 20′ N and 11° 30′ N, and longitude 3° 30′ E and 7° 20′ E. The state is the largest in terms of land mass with an area of 86,000 km^2. Niger State has three Agro-geographical zones, with variable climatic conditions: Zone A (Southern zone) with eight local governments areas (LGAs) (Lapai, Bida, Agaie, Katcha, Edati, Gbako, Lavun and Mokwa) having many rivers, streams and ponds, fadamas for rice farming and large grazing lands; zone B (Eastern zone), with nine LGAs (Rafi, Shiroro, Bosso, Chachanga, Munya, Oaikoro, Gurara, Tafa and Suleja) many mountains, trees, and few rivers and streams, arable and grazing lands; and zone C (Northern zone), with eight LGAs (Agwara, Borgu, Rijau, Magana, Mariga, Mashegu, Kontagora and Wushishi) with few rivers and streams, arable and large grazing areas, and many stock routes[15] (Figure 1).

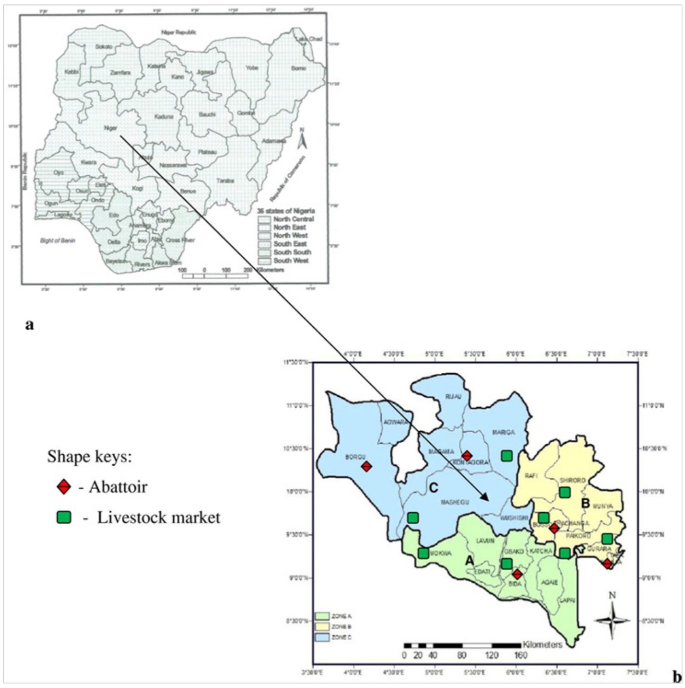

Figure 1 Map of Niger State Showing Study Sites

Target population

Study populations were trade cattle that originated from nomadic and sedentary pastoral herds domiciled in the three agro-geographical zones.

Sampling method and bovine fascioliosis infection data

Retrospective abattoir surveys were conducted at five municipal abattoirs, located at Minna, Suleja, Bida, Kontagora and New-Bussa cities which involve the retrieval and analysis of meat inspection data from the abattoirs carried out between January 2004 and December 2014. Records of monthly and annual returns from the abattoirs were scrutinised condemned as a result of infection with *F. gigantica*. The meat inspection was performed by certified inspectors in accordance with the standards of Livestock and Meat Industries Act of the Republic of Nigeria, under the supervision of the Chief Veterinary Officer in the Department of Veterinary Services of the Ministry of Agriculture, Niger Stat.[15]

Environmental data

In this study, a total of 19 bioclimatic variables of present climate (1950 – 2000) for Nigeria were downloaded from http://www.worldclim.org/ (Worldclim database version 1.4) at 1 km spatial resolution and were used in the prediction of bovine fascioliosis distribution as follows: BIO1 - Annual Mean Temperature, BIO2 - Mean Diurnal Range, BIO3 - Isothermality, BIO4 - Temperature Seasonality, BIO5 - Maximum Temperature of Warmest Month, BIO6 - Minimum Temperature of the Coldest Month., BIO7 - Temperature Annual Range, BIO8 - Mean Temperature of Wettest Quarter, BIO9 - Mean Temperature of Driest Quarter, BIO10 - Mean Temperature of Warmest Quarter, BIO11 - Mean Temperature of Coldest Quarter, BIO12 - Annual Precipitation, BIO13 - Precipitation of Wettest Month, BIO14 - Precipitation of Driest Month, BIO15 - Precipitation Seasonality, BIO16 - Precipitation of Wettest Quarter, BIO17 - Precipitation of Driest Quarter, BIO18 - Precipitation of Warmest Quarter and BIO19 - Precipitation of Coldest Quarter. Elevation data derived from the Shuttle Radar Topography Mission were also downloaded from http://www.worldclim.org/. These bioclimatic variables can be summarized into 3 main variables: altitude, temperature and precipitation.

Ecological niche modeling

The potential distribution of bovine fascioliosis was modelled using MaxEnt software version 3.3.3k download from http://www.cs.princeton.edu/~schapire/maxent/. MaxEnt uses environmental data at occurrence and background locations to predict the distribution of a species across a landscape.[16,17] This modeling tool was selected based on the reasons of Sarma et al.[18] which is a presence-only modeling algorithm (i.e. absence data are not required). Its performance has been relatively better than other modelling methods and has hardly been influenced by small sample sizes and hence prediction will be relatively robust. It has been shown to be among the top performing modeling tools by Elith et al.[19] Probability of presence of bovine fascioliosis was estimated by MaxEnt using the mean prevalence of bovine fascioliosis obtained for the five municipal abattoir in Niger State, Nigeria which served as the presence records for generation of background point used in finding the maximum entropy distribution.[18] Regularization of the prevalence was performed to control over-fitting. MaxEnt produced a logistic output format used in the production of a continuous map that provides a visual graded prevalence with an estimated probability of acquiring infection with Fasciola species between 0 and 1. This map distinguishes areas of high and low risk for bovine fascioliosis.[18] The 19 environmental variables and the elevation data obtained were used for the ecological niche modeling. The level of significance of contribution of the altitude and 19 bioclimatic variables was used to calculate jack knife (a method of assessing the variability of data by repeating calculations on the sets of data obtained each time by removing one value from the complete set) and area under the receiver operating characteristics curve (AUC) was used to evaluate the model performance. The AUC values vary from 0.5 to 1.0; an AUC value of 0.5 showed that model predictions were not better than random, values <0.5 were worse than random, values from 0.5 to 0.7 signified poor performance, values from 0.7 to 0.9 signifies reasonable/moderate performance and values >0.9 indicated high model performance.[20] Model validation was performed according to Sarma et al.[18] using the 'sub-sampling' procedure in MaxEnt. About 75% of the parasites prevalence data were used for model calibration and the remaining 25% for model validation. Ten replicates were run and average AUC values for training and test datasets were calculated. Maximum iterations were set at 5000. Sensitivity and specificity of infections were also measured. Sensitivity, which was also named the true positive rate, can measure the ability to correctly identify areas infected. Its value equals the rate of true positives and the sum value of true positives and false negatives. Specificity, which was also named the true negative rate, can measure the ability to correctly identify areas uninfected. Its value equals the rate of true negatives and the sum value of false positives and true negatives.

Data collection and analysis

The prevalence of fascioliosis was calculated as the number of cattle infected with Fasciola expressed as a percentage of the total number of cattle slaughtered, and was calculated annually for each abattoir. Data were analysed using one-way analysis of variance (ANOVA) followed by turkey's Test. Statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) software (version 21.0 for windows; SPSS Inc., Chicago, IL). Statistical significance was set at $p<0.05$. Map visualization was performed on DIVA-GIS version 7.5.0 using grid file output of MaxEnt with the geographic area restricted to Niger State. Six classes of probabilities were given a specific colour for visual representation of model results ranging from low risk to high risk as follows: 0 – 0.1, 0.1 – 0.2, 0.4 - -0.6, 0.6 – 0.8 and 0.8 – 1.0 with varying colours.

Results

Spatial distribution of bovine fascioliosis in niger state

The mean prevalence of bovine fascioliosis in Niger State, Nigeria is 1.46% over a ten years period (Table 1). The average prevalence from the five municipal abattoirs; Minna, Suleja, Bida, Kotangora and New Bussa were 1.31, 1.70, 1.12, 1.05 and 1.24% respectively. No significant difference ($P>0.05$) in the prevalence of bovine fascioliosis among the five municipals. The yearly prevalence of bovine Fascioliosis were significantly different ($p<0.05$) with year 2010 having the highest prevalence of 7.40% while year 2013 had the least prevalence of 0.42% (Figure 2)(Table 1).

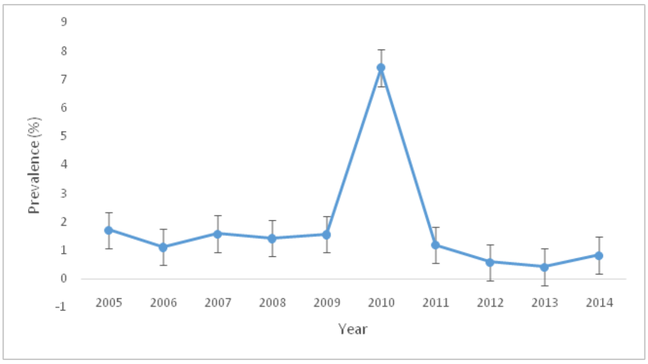

Figure 2 Annual Trend of Bovine Fascioliosis in Niger State, Nigeria

Table 1 Annual Prevalence of Bovine Fascioliosis at Five Municipal Abattoirs in Niger State, Nigeria

Year	Minna		Suleja		Bida		Kontagora		New Bussa		Total	
	NE	NP (%)	NE	NP (%)	NE	NP (%)	NE	NP (%)	NE	NP (%)	NE	NP (%)
2005	34658	785(2.26)	103704	1538 (1.48)	30292	578 (1.91)	26268	411 (1.56)	21416	378 (1.77)	216338	3690 (1.71)
2006	45940	701(1.53)	137977	1188 (0.86)	42437	533 (1.26)	38139	432 (1.13)	19845	290 (1.46)	284338	3144 (1.11)
2007	41852	819(1.96)	127596	1751 (1.37)	35763	673 (1.88)	32168	498 (1.55)	19947	321 (1.61)	257326	4062 (1.58)
2008	42921	836(1.95)	131671	1647 (1.25)	33286	584 (1.75)	31994	297 (0.93)	23056	377 (1.64)	262928	3741 (1.42)
2009	34184	779(2.28)	119552	1731 (1.45)	29067	499 (1.72)	30621	369 (1.21)	23965	316 (1.32)	237389	3694 (1.56)
2010	37208	597(1.60)	121278	16671 (13.75)	31334	379 (1.21)	31169	158 (0.51)	22789	223 (0.98)	243778	18028 (7.40)
2011	38228	652(1.71)	133846	1165 (0.87)	31052	471 (1.52)	23789	346 (1.45)	23465	335 (1.43)	250380	2969 (1.19)
2012	89782	601(0.67)	301418	1109 (0.37)	49609	423 (0.85)	35798	418 (1.17)	29100	362 (1.24)	505707	2913 (0.58)
2013	129999	670(0.52)	389979	1265 (0.32)	94967	312 (0.33)	49971	381 (0.76)	35763	331 (0.93)	700679	2959 (0.42)
2014	44174	640(1.45)	148642	1107 (0.74)	56793	402 (0.71)	45107	307 (0.68)	39055	275 (0.70)	333771	2731 (0.82)
Total	538946	7080(1.31)	1715663	29172 (1.70)	434600	4854 (1.12)	345024	3617(1.05)	258401	3208 (1.24)	3292634	47931 (1.46)

Source: Yatswako & Alhaji.[15]

NE - Annual Slaughtered Cattle Trade Cattle

NP - Annual Cases of Bovine Fascioliosis

% - Annual Prevalence

Predicted risk of bovine fascioliosis infection

The model prediction of bovine Fascioliosis reveals that Wushishi, Katcha, Gbako, Bosso and parts of Shiroro and Rafi LGAs lies within the high risk areas with probability of occurrence ranging from 0.8 – 1. Large part of Wushishi LGA fell within the high risk region. The suitability of conditions that favours the spread of this disease reduces

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moving northward of LGAs in Zone C. Rijau and Agwara were the least in prevalence of bovine fascioliosis with probability of 0 – 0.1. Also, parts of Borgu, Mariga and Magana LGAs fell within the low risk areas with probability of 0 – 0.1 (Figure 3) (Figure 4).

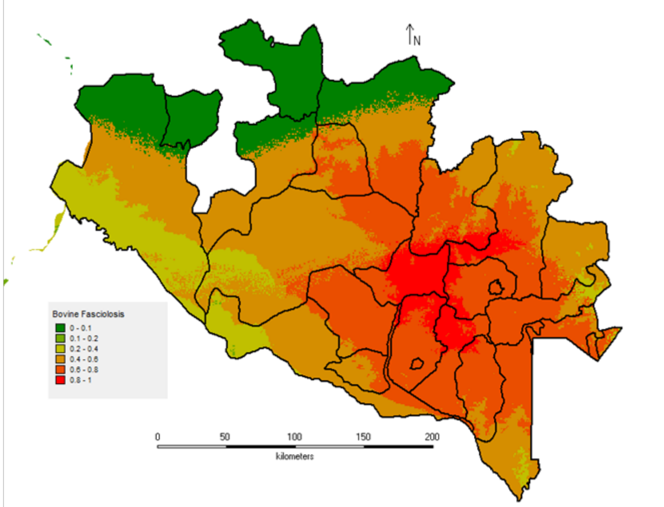

Figure 3 Predicted prevalence of Bovine Fascioliosis in Niger State, Nigeria

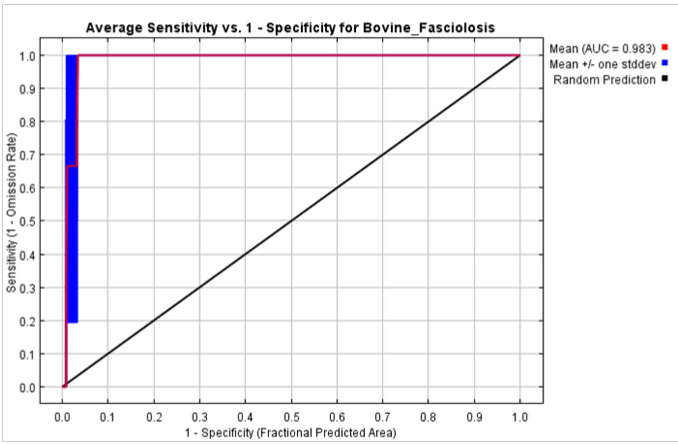

Figure 4 Area Under the Curve (AUC) (Red line indicates the mean value for 10 MaxEnt replicate runs and blue indicates the standard deviation)

Model performance and influencing factors

The receiver operating characteristics (ROC) curve obtained as an average of the 10 replication runs is shown in Fig. 4. Specificity was calculated. The average and standard deviation of the area under the curve for the 10 replicate runs for this infection was 0.983±0.011. These values showed an excellent performance of the modeling software as an AUC value of greater than 0.80 showed higher sensitivity and specificity for the presence of these parasites. The relative importance of each environmental variable to the prevalence of bovine fascioliosis was assessed with the jackknife test in fig. 6a&b which gave a total training gain of 2.9 (red bar) (Figure 5) and an AUC value of 0.98 (red bar) (Figure 6). The jackknife test indicated that precipitation of the coldest quarter, mean temperature of coldest quarter, mean temperature of coldest quarter and precipitation of wettest quarter were the three variables when used alone, will affect the prevalence of bovine fascioliosis the most. These three variables were more informative when used in predicting the prevalence of bovine fascioliosis.

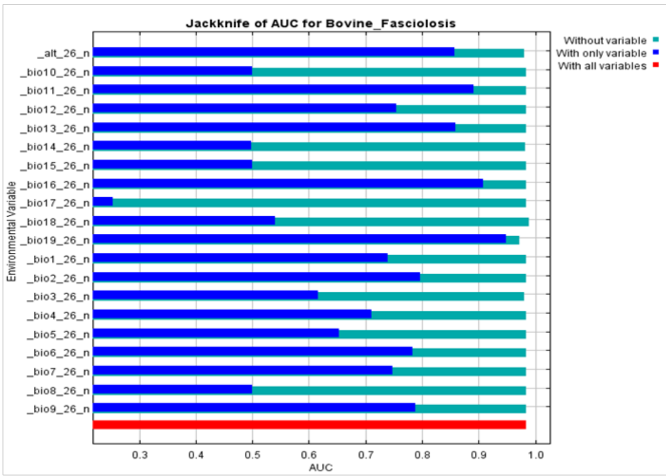

Figure 5 Analysis of training gain. The dark blue, light blue and red bars represent results of the model with each individual variable, all the remaining variables and all variables respectively

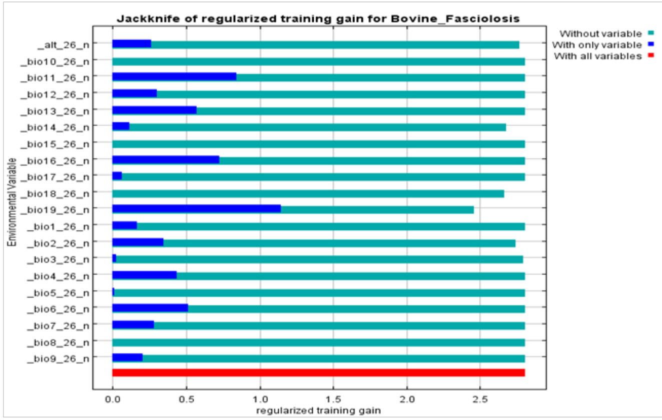

Figure 6 Jacknife Analysis of AUC. The dark blue, light blue and red bars represent results of the model with each individual variable, all the remaining variables and all variables respectively

Discussion

The result of this study indicated low prevalence of fascioliosis in cattle in Niger State, Nigeria over the ten years period. Magaji et al.[21] reported the presence of this parasite in their study in Sokoto State, Nigeria. Similar abattoir studies in Zimbabwe,[22] Kenya[8,23] and Tanzania[24,25] reported a higher prevalence of 37.1%, 8%, 26%, 16.5% and 8.6%, respectively. The present study is similar to the study of Mochankana and Robertson [26] in Botswana with prevalence of 0.1%. The low prevalence observed in this study might be attributed to the provision of better veterinary services and increase in consultancy services to farmers on livestock management, which could reduce the prevalence of fascioliosis. This study suggest that bovine fascioliosis is of low clinical economic importance in Niger State, Nigeria. Other studies using bile samples from slaughtered cattle in different countries showed higher prevalence of fascioliosis; 25.46% by Khan et al.[27] in Pakistan, 26.84% by Gul et al. [28] in India, 27.26% and 25.2% by Kabir et al.[29] & Affroze et al.[30] from different provinces of Bangladesh, 25.9% by Mungube et al.[31] in Kenya, 26.55% by Nega et al.[32] in Ethopia, 23.96% by Asressa et al.,[33] in Ethiopia. The difference in prevalence could be due to the difference in agro climatic variations (rainfall, temperature), the management conditions under which the cattle were reared and the difference in grazing area. The high humidity of the region also provided the needed condition to encyst the metacercariae. Qureshi et al.[34] reported that metacercariae can be found on vegetation in large number during rainy season and at early dry season along river banks, lakes, and streams. The sensitivity of liver inspection at post-mortem has been reported to be 63–71% by Khaitsa et al.[35] & Rapsch et al.[36] who indicated that meat inspection for liver fluke may exhibits a sensitivity of 63.2% (55.6–70.6%), meaning that the true levels of infection may be between 1.5 and 2 times the apparent prevalence. Although useful for the confirmation of patently infected animals, sensitivity of data from abattoir records may not be optimal, which is a major limitation.[15] The modeling result indicated that precipitation of the coldest quarter, mean temperature of coldest quarter and precipitation of wettest quarter were the environmental variables that favours high prevalence of bovine Fascioliosis. The South-Eastern part of Niger State was observed to have a higher predicted prevalence as a result of the higher precipitation of the region and warmer temperature. Altitude do not have significant impact on the prevalence of bovine fascioliosis.

Conclusion

The findings of this study revealed that bovine fascioliosis is endemic in Niger State Nigeria with little economic importance. The South-Eastern region of the state are at high risk of infection than other regions as a result of the higher level of precipitation coupled with lower temperature. The temperature of the coldest quarter and precipitation of the wettest month are the major environmental variables that affect majorly the distribution of this disease.

Recommendation

We recommend that consultancy services be rendered by veterinary experts to cattle farmers coupled with administration of drugs. Also, the rearing of cattle in high risk areas should be regulated and restricted.

Acknowledgments

None.

Conflict of interest

Author declares that there is no conflict of interest.

References

1. Mas-Coma S, Bargues MD, Valero MA. Fascioliasis and other plant-borne trematoda zoonoses. *Int J Parasitol.* 2005;35(11-12):1255–1278.
2. Andrews SJ. The life cycle of Fasciola hepatica. In: Dalton JP, editor. *Fasciolosis*. Wallingford: CAB International; 1999:6–21. 1999.
3. Gajewska A, Smaga-Kozłowska K, Wiśniewski M. Pathological changes of liver in infection of Fasciola hepatica. *Wiadomosci Parazytologiczne*. 2005;51:115–123.
4. Mas-Coma S, Valero MA, Bargues MD. Fasciola, lymnaeids and human fascioliasis, with a global overview on disease transmission, epidemiology, evolutionary genetics, molecular epidemiology and control. *Adv Parasitol*. 2009;69:41–146.
5. Abunna F, Asfaw L, Megersa B, et al. Bovine fasciolosis: coprological, abattoir survey and its economic impact due to liver condemnation at Soddo municipal abattoir, Southern Ethiopia. *Trop Anim Health Prod.* 2010;42(2):289–292.
6. Biu AA, Ahmed MI, Mshelia SS. Economic assessment of losses due to parasitic diseases common at the Maiduguri abattoir, Nigeria. *African Sci*. 2006;7(3):143–145.
7. WHO. *Control of food-borne trematode infections*. 1995.
8. Mungube EO, Bauni SM, Tenhagen BA, et al. The prevalence and economic significance of *Fasciola gigantica* and *Stilesia hepatica* in slaughtered animals in the semi-arid coastal Kenya. *Trop Anim Health Prod*. 2006;38(6):475–483.
9. Schweizer G, Braun U, Deplazes P, et al. Estimating the financial losses due to bovine fasciolosis in Switzerland. *Vet Rec*. 2005;13;157(7):188–193.
10. Phiri IK, Phiri AM, Harrison LJ. The serum glucose and [beta]-hydroxybutyrate levels in sheep with experimental *Fasciola hepatica* and *Fasciola gigantica* infection. *Vet Parasitol*. 2007;143(3-4):287–293.
11. Ikem MM. Strongleides papillosus, Neoascaru vitulorum acquired mixed infections of calves in Plateau State area of Northern Nigeria and treatment given. *Bulletin of Epizootic Diseases of Africa*. 1970;18:339–345.
12. Chiejina SN. The epizootiology and control of parasitic gastro-enteritis of domesticated ruminants in Nigeria. *Helminthology*. 1986;55:413–429.
13. Phiri AM. Common conditions leading to cattle carcass and offal condemnations at 3 abattoirs in the western province of Zambia and their zoonotic implications to consumers. *J S Afr Vet Assoc*. 2006;77(1):28–32.
14. Cadmus SI, Adesokan HK. Causes and implications of bovine organs/offal condemnations in some abattoirs in Western Nigeria. *Trop Anim Health Prod.* 2009;41(7):1455–1463.
15. Yatswako S, Alhaji NB. Survey of bovine fasciolosis burdens in trade cattle slaughtered at abattoirs in North-central Nigeria: The associated predisposing factors and economic implication. *Parasite Epidemiol Control.* 2017;22;2(2):30–39.
16. Phillips SJ, Dudík M. Modeling of species distributions with MaxEnt: new extensions and a comprehensive evaluation. *Ecography*. 2008;31(2):161–175.
17. Phillips SJ, Anderson RP, Schapire RE. Maximum entropy modeling of species geographic distributions. *Ecological Modelling*. 2006;190:231–259.
18. Sarma RR, Munsi M, Ananthram AN. Effect of climate change on invasion risk of giant African snail (*Achatina fulica Ferussac* 1821: Achatinidae) in India. *PLoS ONE*. 2015;10(11):e0143724.
19. Elith J, Graham CA, Dudık M, et al. Novel methods improve prediction of species' distributions from occurrence data. *Ecogeography*. 2006;29:129–151.
20. Peterson AT, Jorge Soberón, Richard G Pearson, et al. Ecological niches and geographic distributions. Princeton Univ Press. 2011.
21. Magaji AA, Ibrahim K, Salihu MD, et al. Prevalence of fascioliasis in cattle slaughtered in sokoto metropolitan abattoir, Sokoto, Nigeria. *Adv Epid.* 2014:5.
22. Pfukenyi DM, Mukaratirwa S. A retrospective study of the prevalence and seasonal variation of *Fasciola gigantica* in cattle slaughtered in the major abattoirs of Zimbabwe between 1990 and 1999. *Onderstepoort J Vet Res.* 2004;71(3):181–187.
23. Kithuka JM, Maingi N, Njeruh FM, et al. The prevalence and economic importance of bovine fasciolosis in Kenya: An analysis of abattoir data. *Onderstepoort J Vet Res.* 2002;69(4):255-262.
24. Mellau LSB, Nonga HE, Karimuribo ED. A slaughterhouse survey of liver lesions in slaughtered cattle, sheep and goats at Arusha, Tanzania, *Research Journal of Veterinary Sciences*. 2010;3:179–188.
25. Nonga H, Mwabonimana, M, Ngowi H, et al. A retrospective survey of

liver fasciolosis and stilesiosis in livestock based on abattoir data in Arusha, Tanzania. *Tropical Animal Health and Production*. 2009;41:1377–1380.

26. Mochankana ME, Robertson ID. A retrospective study of the prevalence of bovine fasciolosis at major abattoirs in Botswana. *Onderstepoort J Vet Res.* 2016;83(1):a1015.
27. Khan MK, Sajid MS, Khan MN, et al. Bovine fasciolosis: Prevalence, effects of treatment on productivity and cost benefit analysis in five districts of Punjab, Pakistan. *Research in Veterinary Science*. 2009;87:70–75.
28. Gul N, Tak H, Fazilli KM, et al. Prevalence of *Fasciola* infection in slaughtered Animals in Kashmir. *International Journal of Veterinary Sciences and Animal Husbandry*. 2016;1(2):30–36.
29. Kabir MHB, Eliyas M, Hashem MA, et al. Prevalence of zoonotic parasitic diseases of domestic animals in different abattoir of Comilla and Brahman Baria region in Bangladesh. *Univ J Zool Rajshahi Univ*. 2010;28:21–25.
30. Affroze S, Begum N, Islam MS, et al. Risk Factors and Gross Pathology of Bovine Liver Fluke Infection at Netrokona District, Bangladesh. *J Anim Sci Adv.* 201;3(2):83–89.
31. Mungube EO, Sila DM, Kariuki CW, et al. A cross sectional survey on fasciolosis in selected settlements of Taveta Division, Coast Province, Kenya. *Livestock Research for Rural Development*. 2012; 24(4):1–8.
32. Nega M, Bogale B, Chanie M. et al. Comparison of Coprological and Postmoretem Examinations Techniques for the Determination of Prevalence and Economic Significance of Bovine Fasciolosis. *Journal of Advanced Veterinary Research*. 2012;2:18–23.
33. Asressa Y, Hassen K, Tewodros F, et al. Prevalence of cattle fluke's infection at Andassa Livestock Research Center in north-west of Ethiopia. *Veterinary Research Forum*. 2012;3(2):85–89.
34. Qureshi AW, Tanveer A, Maqbool A, et al. Seasonal and monthly prevalence pattern of fascioliasis in buffaloes and its relation to some climatic factors in north eastern areas of Punjab, Pakistan. *Iranian J Vet Res*. 2012;13(2):134–137.
35. Khaitsac ML, Hammond JA, Opuda-Asibo J. Use of meat inspection records in veterinary planning. *Bull Epizoot Dis Afri*. 1994;42: 317–326.
36. Rapsch C, Schweizer G, Grimm F, et al. Estimating the true prevalence of *Fasciola hepatica* in cattle slaughtered in Switzerland in the absence of an absolute diagnostic test. *Int J Parasitol.* 2006;36(10-11):1153–1158.

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