Rift Valley fever and *Brucella* spp. in ruminants, Somalia

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**Abstract**

**Background:** Fourteen-years after the last Rift Valley fever (RVF) virus (RVFV) outbreak, Somalia still suffers from preventable transboundary diseases. The tradition of unheated milk consumption and handling of aborted materials poses a public health risk for zoonotic diseases. Limited data are available on RVF and *Brucella* spp. in Somalian people and their animals. Hence, this study has evaluated the occurrence of RVFV and *Brucella* spp. antibodies in cattle, goats and sheep sera from Afgoye and Jowhar districts of Somalia.

**Methods:** Serum samples from 609 ruminants (201 cattle, 203 goats and 205 sheep), were serologically screened for RVF by a commercial cELISA, and *Brucella* species by modified Rose Bengal Plate Test (mRBPT) and a commercial iELISA.

**Results:** Two out of 609 (0.3 %; 95 %CI: 0.04–1.2 %) ruminants were RVF seropositive, both were female cattle from both districts. Anti-*Brucella* spp. antibodies were detected in 64/609 (10.5 %; 95 %CI: 8.2–13.2 %) ruminants by mRBPT, which were 39/201 (19.4 %) cattle, 16/203 (7.9 %) goats and 9/205 (4.4 %) sheep. Cattle were 5.2 and 2.8 times more likely to be *Brucella*-seropositive than sheep (p = 0.000003) and goats (p = 0.001), respectively. When mRBPT-positive samples were tested by iELISA, 29/64 (45.3 %; 95 %CI: 32.8–58.3 %) ruminant sera were positive for *Brucella* spp. Only 23/39 (58.9 %) cattle sera and 6/16 (37.5 %) goat sera were positive to *Brucella* spp. by iELISA.

**Conclusions:** The present study showed the serological evidence of RVF and brucellosis in ruminants from Afgoye and Jowhar districts of Somalia. Considering the negligence of the zoonotic diseases at the human-animal interface in Somali communities, a One Health approach is needed to protect public health.

**Keywords:** Neglected zoonotic diseases, RVF, *Brucella* spp., One Health
documented outbreaks in humans and livestock in Africa including Somalia, and in Arabian Peninsula and some Indian Ocean Islands [5]. The RVF is a World Organization for Animal Health (OIE) listed disease due to its potential to cause human illness and deaths, high livestock abortions and deaths, and a setback to international livestock trade [8]. The disease is often linked to persistent heavy rainfall and flooding, which causes the emergence of infected mosquitoes, Aedes spp., which is already infected via transovarial transmission, and thus, lead to spread of the virus to animals and humans [6].

Previous studies have described outbreaks of RVF in Somalia and Kenya [9], and recent data on the seroprevalence of the disease has been described in Ethiopia [10]. However, routine surveillance for RVFV in Sub-Saharan African countries is limited and outbreaks are underreported [6]. A previous study on RVF in Saudi Arabia has found seroprevalence of 22.05 and 8.49 % in sheep and goats imported from Somalia, respectively [11]. However, data on RVF in Southern Somalia is lacking.

Brucellosis is a neglected bacterial zoonotic disease that severely hinders livestock productivity and human health [12, 13]. The disease is caused by Brucella spp., with B. abortus and B. melitensis of particular importance in ruminant and human cases. Transmission from animals to humans occurs mainly through the ingestion of infected dairy products and direct contact with an infected animal [12, 14].

Previous studies on serological evidence of brucellosis throughout sub-Saharan Africa have been reported [15, 16]. However, it remains a neglected disease in Somalia with few data available for ruminants, the majority dated before the Civil War in the country [17–20]. The reported Brucella spp. prevalence in the country is of 4 % in sheep, 4.9 % in goats [21] and 5.5 % in cattle [19].

After 20 years of crisis, Somalia is still politically unstable, famine and lacking state-of-the-art knowledge on zoonotic diseases. The tropical climate and prevailing tradition of unheated milk consumption, handling of aborted materials and reproductive excretions with bare hands favours disease spread. Herein, we aimed to evaluate the presence of antibodies specific to RVFV and Brucella spp. in cattle, goats and sheep from two important districts of Somalia.

Materials and methods

A total of 609 ruminant blood samples (201 cattle, 203 goats and 205 sheep) from Afgooye (2°08′47.67″N 45°07′08.11″E) and Jowhar (2°46′38.72″N 45°30′05.85″E) districts of Somalia (Fig. 1), collected from November 2017 to February 2018, previously surveyed for other pathogens [22] were evaluated. Blood and serum samples were kept at -20 °C for future studies. Serum samples were screened for RVFV by a commercial cELISA (ID Screen® Rift Valley fever Competition Multi-species, ID.vet, Grabels, France), which detects IgG antibodies specific to the RVFV nucleoprotein (NP) with 91–100 % sensitivity and 100 % specificity [23]. For Brucella spp., serum samples were initially tested by modified Rose Bengal Plate Test (mRBPT) with 89.6 % sensitivity and 84.5 % specificity [24]. The mRBPT positive samples were re-tested by a commercial indirect ELISA (iELISA) (ID Screen® Brucellosis Serum Indirect Multi-species, ID.vet, Grabels, France), which detects the IgG antibodies specific to Brucella Lipopolysaccharide (LPS) antigens with 96.8 % sensitivity and 96.3 % specificity [24]. The surveyed two districts are drained by Shabelle river and have suitable ecological conditions for vector breeding and disease occurrence. The cattle and small ruminants in these districts are kept under an extensive animal husbandry system and are often co-grazed.

Data were compiled and analyzed in Epi Info™ software, version 7.2.3.1 (Centers for Disease Control and Prevention, CDC, USA). Chi-square test was used to determine the difference between whether individual factors were associated with seropositivity to RVFV and Brucella spp. Odds ratio (OR), 95 % confidence interval and p-values were calculated separately for each variable. Results considered significantly different when p < 0.05.

Results

Two out of 609 (0.3 %; 95 % CI: 0.04–1.2 %) ruminant sera showed positive reaction for RVF V protein, that were adult female cattle from Afgooye or Jowhar districts. Anti-Brucella spp. antibodies were detected in 64/609 (10.5 %; 95 % CI: 8.2–13.2 %) ruminants by mRBPT, which were 9/205 (4.4 %; 95 % CI: 2–8.2 %) sheep, 16/203 (7.9 %; 95 % CI: 4.6–12.5 %) goats and 39/201 (19.4 %; 95 % CI: 14.2–25.6 %) cattle. Cattle were more likely to be seropositive to Brucella spp. than sheep (OR: 2.5; χ² = 10.1, p = 0.001) and goats (OR: 2.8; χ² = 11.4, p = 0.001). Association between districts (p = 0.453) or sex (p = 0.903) and seropositivity to Brucella spp. in ruminants was not found. When mRBPT-positive samples were tested by iELISA, 29/64 (45.3 %; 95 % CI: 32.8–58.3 %) ruminant sera also tested positive for Brucella spp. Only 23/39 (58.9 %) cattle and 6/16 (37.5 %) goat sera were reactive to Brucella spp. LPS antigens by iELISA. The seroprevalence of RVF and Brucella spp. for each variable evaluated is summarized in Table 1.

Discussion

A limited number of studies on neglected zoonotic diseases have been reported in animals and humans in
Somalia [22, 25]. Somalia is a livestock-dependent country in East Africa, which borders Kenya and Ethiopia where zoonotic transboundary diseases are often documented [6, 10].

To the best of the author’s knowledge, this is the first study on RVF in cattle, goats, and sheep in Afgoye and Jowhar districts of Somalia. Herein, overall, 1% cattle were seropositive to RVFV by cELISA, and all goats and sheep tested negative. A previous study has reported high seroprevalence rates of RVFV in sheep (22.05%, 30/136) and goats (8.49%, 9/106) imported from Somalia to Saudi Arabia for pilgrimage season in 2011 [11]. It is important to state that neither the origin of the imported animals nor the quarantine status after arriving in Saudi Arabia was specified in that study. Moreover, a previous study in northern Somalia have found an overall RVF seroprevalence of 2% in sheep and 5% in goats sampled in Somaliland in 2001 and in Puntland in 2003 [26]. The last documented RVF outbreak occurred in 2007 in southern Somalia, specifically in the Middle and Lower Juba and Gedo regions both located at the border of Kenya, where the outbreak focus was reported [27].

In the present study, we evaluated ruminant’s serum samples from Afgoye and Jowhar districts, where RVF outbreaks have never been reported, collected between November 2017 to February 2018, which represents the dry season in Somalia [22] and may have influenced the low seropositivity found due to the low survival and proliferation of Aedes spp. Differing, a higher RVF prevalence has been found in sheep and goats from the Nugal Valley, Somaliland, in 2001 [26]. Our results are in line with the RVF findings obtained in Egypt (0% in goats and 0.46% in sheep) after 12 years from the last RVF outbreak in that country [28]. Thus, we hypothesize that animals evaluated by Mohamed et al. [11] may be the remnant livestock from the last documented RVFV outbreak in Somalia, which needs to be further investigated. Finally, a recent RVF outbreak has been confirmed in Isiolo, Mandera, Murang’a and Garissa counties of Kenya in February 2021 [29]. Thus, considering that free cattle movement between Kenya and Somalia occurs, RVF cases may also occur in Somalia, mainly during the rainy season.

Herein, the overall 10.5% ruminants (19.4% cattle, 7.9% goats and 4.4% sheep) were seropositive for Brucella spp. by mRBPT. Similar findings were found in
Brucella spp. in ruminants in Somalia. Considering the negligence of the zoonotic diseases at the human-animal interface in Somali communities, there is a need to promote the One Health concept among multi-sectoral professionals and decision-makers for better and sustainable integrated health development and implementing effective control strategies against these zoonotic diseases.

**Abbreviations**

ARTC: Abaar Research and Training Centre; AU: Abaar University; Brucella LPS: Brucella Lipopolysaccharide; CDC: Centers for Disease Control and Prevention; cELISA: Competitive Enzyme Linked ImmunoSorbent Assay; CI: confidence interval; CNPq: Conselho Nacional de Desenvolvimento Científico e Tecnológico; GDP: Gross Domestic Product; GOHi: Global One Health initiative; iELISA: indirect ELISA; cELISA: competitive ELISA; RVF: Rift Valley fever

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**Authors’ contributions**

AAHK and AAY collected the data. AAHK, AMO, MAS, OMA, AAY, AMI and RFCV carried out the methodology. AAHK, AMO and RFCV performed the data analysis. AAHK, AMO, and RFCV drafted the manuscript. All authors edited and approved the final manuscript.

**Availability of data and materials**

Not applicable.

**Declarations**

**Ethics approval and consent to participate**

This study was approved by the ethical committee of Abaar University, Somalia (reference number AU/ARTC/EC/04/2017). Cattle, goats and sheep...
owners gave consent to sample their animals. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References

1. Ibrahim M, Schelling E, Zinssig J, Hattendorf J, Andargie E, Tschopp R. Seroprevalence of brucellosis, Q-fever and Rift Valley fever in humans and livestock in Somali Region, Ethiopia. PLoS Negl Trop Dis, 2021, 15(1): e0008100. doi: https://doi.org/10.1371/journal.pntd.0008100.

2. Kanouté, Y. B., Gragnon, B. G., Schindler, C., Bonfoh, B., & Schelling, E. Reprint – Epidemiology of brucellosis, Q Fever and Rift Valley Fever at the human and livestock interface in northern Côte d’Ivoire. Acta Tropica, 2017, 175, 121–129. doi: https://doi.org/10.1016/j.actatropica.2017.08.013.

3. FAO – Food and Agriculture Organization. Improved animal health for poverty reduction and sustainable livelihoods. FAO, Animal production and health. 2002, paper 153. ISBN 92-5-104757-X. http://www.fao.org/3/y3542e/y3542e00.htm.

4. FAO – Food and Agriculture Organization. Somalia, towards a Livestock Slaughterhouses, Somali Meat Company, Mogadishu, Somalia. 4Global One Cooperative Programme. European Union, 2004, 1–170.

5. Pawska JT. Rift Valley fever. Rev. Sci. Tech. Off. Int. Epiz., 2015, 34(2), 375–389. doi: https://doi.org/10.20506/rst.34.2.32364.

6. Clark MHA, Wartime GM, Di Nardo A, Lyons NA, Gubbins S. Systematic literature review of Rift Valley fever virus seroprevalence in livestock, wildlife and humans in Africa from 1968 to 2016. PLoS Negl Trop Dis, 2018, 12(7): e0006627. doi: https://doi.org/10.1371/journal.pntd.0006627.

7. Daubney R, Hudson JR, Garnham PC. Enzootic hepatitis or rift valley fever. An undescribed virus disease of sheep cattle and man from East Africa. J Pathol Bacteriol, 1931:34(4):545–79. https://doi.org/10.1002/path.1700340418.

8. OIE. Terrestrial Animal Health Code Chapter 8.15. Infection with Rift Valley fever virus and sheep in Somalia. Parasitology, 2020, 147, 1786–1791. doi: https://doi.org/10.1016/j.sjpvi.2020.00178X.

9. Kortekaas J, Kant J, Vloet R, Cêtre-Sossah C, Marianneauc P, Lacotec S, Banyard AC et al. 2013, ‘European ring trial to evaluate ELISAs for the diagnosis of infection with Rift Valley fever virus’, J Virol Methods, 2013, 187(1), 177–181. doi: https://doi.org/10.1016/j.jvirm.2012.09.016.

10. Getachew T, Getachew G, Sintayehu G, Getnet M, Farah A. Bayesian estimation of sensitivity and specificity of Rose Bengal, complement fixation, and indirect ELISA tests for the diagnosis of bovine brucellosis in Ethiopia. Vet Med Int. 2016:1–5. doi: https://doi.org/10.1155/2016/8032753.

11. Hassan-Kadle AA. A Review on Ruminant and Human Brucellosis in Somalia. Open J Vet Med, 2015, 5, 133–137. doi: https://doi.org/10.4236/ojvm.2015.56018.

12. Soumagne B, Tempia S, Cagnolati V, Mohamed A, Van Huylenbroeck G, Berkvens D. Screening for Rift Valley fever infection in northern Somalia: a GIS based survey method to overcome the lack of sampling frame. Vet Microbiol. 2007, 15;121(3):249–56. doi: https://doi.org/10.1016/j.vetmic.2006.12.017.

13. Nderitu L, Lee JS, Omolo J, Omolo S, O’Guinnt MH, Hightower A, Mosha F, Mohamed M, Munyua P, Ng’ang’a Z, Hetti K, Seb M, Feink DR, Breiman R, Njenga MK. Sequential Rift Valley fever outbreaks in eastern Africa caused by multiple lineages of the virus. J Infect Dis, 2011, 1;203(5):655–66. doi: https://doi.org/10.1093/infdis/jiq004.

14. Moz C, Gwida M, El-Ashker M, El-Diasty M, El-Beskawy M, Ziegler U, Eiden M, Groschup MH. Seroprevalence of Rift Valley fever virus in livestock during inter-epidemic period in Egypt, 2014/15. BMC Vet Res, 2017, 5, 13:187. doi: https://doi.org/10.1186/s12917-017-1099-8.

15. Volland S. Contributions to the epidemiology of Rift Valley fever virus. Berlin, 1938. 120 S.

16. World Health Organization. (2021) Rift Valley Fever – Kenya. Available at https://www.who.int/csr/don/12-february-2021-rift-valley-fever-kenya/en/ Accessed 01 March 2021.

17. Cadmus SJB, Ijbone IF, Oputa HE, Adesosen HK, Stack JA. Serological survey of brucellosis in livestock animals and workers in Ibadan Nigeria. Afr J Biomed Res. 2006;9:153–68.

18. Mohan MO, Abdulhamid AA, Sarah MAA, Aabba MA. Survey of brucellosis among sheep, goat, cattle and camel in Kassala area, Eastern Sudan. J Anim Vet Adv. 2007,6:635–7.

19. Njuka J, Dione M, Aparamu M, et al. Seroprevalence of brucellosis and risk factors associated with its seropositivity in cattle, goats and humans in Iganga District, Uganda. Pan Afr Med J. 2019;33:59. doi: https://doi.org/10.1186/s12997-019-01596-x.

20. Dean AS, Bonfoh B, Kulo AE, Amidou M, Hattendorf J, Pilo P, Schelling E. Epidemiology of brucellosis and Q Fever in linked human and animal populations in northern togo. PLoS One, 2013, 12(8)5:e71501. doi: https://doi.org/10.1371/journal.pone.0071501.

21. Njouo J, Wareth G, Melzer F, Henning K, Pitz MW, Heller R, Neubauer H. Systematic review of brucellosis in Kenya: disease frequency in humans and...
35. Osoro EM, Munyua P, Omulo S, Ogola E, Ade F, Mbatha P, et al. Strong association between human and animal Brucella seropositivity in a linked study in Kenya, linked study in Kenya, 2012–2013. Am J Trop Med Hyg. 2015;93(2):224–31. doi: https://doi.org/10.4269/ajtmh.15-0113.

36. Kadle AAH, Mohamed SA, Ibrahim AM and Alawad MF. Seroepidemiological study on camel brucellosis in Somalia. Eur Acad Res, 2017; 5(6):2925–42.

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