OPEN ACCESS
Advances in Animal and Veterinary Sciences
Review Article

Review on Current Seroprevalance Status of Common Small Ruminants' Bacterial and Viral Diseases in Tropics Focusing in Malaysia: A Holistic of Current Status Essential to be Study and Known

Faez Firdaus Abdullah Jesse[1,2*], Hamza Abdirahman Hashi[2], Eric Lim Teik Chung[1,3], Mohd Azmi Mohd Lila[4]

[1]Institute of Tropical Agriculture and Food Security, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, [2]Department of Veterinary Clinical Studies, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, [3]Department of Animal Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, [4]Department of Veterinary Pathology and Microbiology, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.

Abstract | Livestock industries are important for economic development in developing countries where small ruminant production is an important and viable sub part of animal industries in Asia. Small ruminant production systems are complex where livestock industries show a vital role in economic development and play a major role in the life of farmers in developing countries. Small ruminant industry has been facing devastating economic losses from major outbreaks of transboundary animal diseases and zoonosis potential such as Brucella, Caseous Lymphadenitis (CLA), Contagious Ecythma (orf), Caprine Arthritis Encephalitis (CAE), Coxaella burnetti (Q fever), Schmallenberg infection (SBV) and Bluetongue. These diseases have become an international nuisance as all regions around the world and particularly in tropic regions can be considered potential risk. Occurrences of these diseases will cause obstacles in the main production of the farm and livestock and need to give detail emphasis to upgrade the herd health programme and uplift disease monitoring programme to enhance biosecurity in ruminant livestock industry particularly in small ruminant. Currently Malaysian Agriculture plan is to uplift and enhance the ruminant production for food security and safety of the country. Therefore, it is important to have current seroprevalance status of common small ruminants' bacterial and viral diseases in tropics focusing in Malaysia where a holistic of current status essential to be study and known.

Keywords | Current, Seroprevalance, Tropics, Malaysia, Small Ruminant, Brucella, Meliodosis, CLA, Orf, CAE, Q fever, Schmallenberg, Bluetongue

Received | August 19, 2019; **Accepted** | January 13, 2020; **Published** | January 22, 2020
***Correspondence** | Faez Firdaus Abdullah Jesse, Institute of Tropical Agriculture and Food Security, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia; **Email:** jesse@upm.edu.my
Citation | Jesse FFA, Hashi HA, Chung ELT, Lila MAM (2020). Review on current seroprevalance status of common small ruminants' bacterial and viral diseases in tropics focusing in Malaysia: A holistic of current status essential to be study and known. Adv. Anim. Vet. Sci. 8(2): 140-146.
DOI | http://dx.doi.org/10.17582/journal.aavs/2020/8.2.140.146
ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

INTRODUCTION

Brucellosis is one of the most important economic and welfare bacterial diseases in goats and sheep and is under a national eradication program globally (Coelho et al., 2007). The disease has also called Malta fever, goat fever, undulant fever and cow, goat, pig and man fever (Bamaiyi et al., 2010). Brucella are facultative intracellular gram-negative cocco-bacilli, non-capsulated and non-spore-forming (Seleem et al., 2010). The disease affects cattle, swine, sheep, goats, camels, equines, and dogs. It may also infect other ruminants and marine mammals (Lopes and Haddad, 2010). The incubation period is extremely variable typically 2-4 weeks and can be 1 week to 2 months or longer (Corbel, 2006). Clinical signs are abortion, prenatal mortality, still birth and reduction in milk yield (Agab, 1997). Pathogenicity of five Brucella species that affects humans has been confirmed are *B. melitensis, B. abortus, B. suis, B. canis and B. marina*. The disease in humans is affected mainly by B. melitensis as the most pathogenic species followed by *B. Suis*. For *B. abortus* it is considered as the mildest type of brucellosis

(Galinska and Zagórski, 2013). Therefore, brucellosis is an important zoonosis causing chronic debilitating diseases in man (Krueger et al., 2014) where unplanned abortion specifically in the first or second semester would take place in brucellosis affected pregnant women. Sagarasaeranee et al. (2017) had carried out a study on seroprevalence of small ruminant brucellosis in Thailand where a total of 103,380 small ruminants from 3,626 herds were tested in this study through national surveillance data in 2013 and the result showed that the seroprevalence of brucellosis were 12.1% (438/3626) at herd level for both goats and sheep. For individual animal level seroprevalence of small ruminant brucellosis in Thailand were 1.4 % (1,297/94722) and 1.6% (139/8658) for goats and sheep respectively. Islam et al. (2010) conducted a study on prevalence and risk factors of brucellosis of goats in Bangladesh where a total of 242 milk and 208 blood samples of goat were collected from three organized goat farms in Bangladesh Agricultural University rural surrounding areas. Milk Ring Test (MRT), serum Rose Bengal test (RBT) and micro agglutination test (MAT) tests were adopted for screening and detection of brucellosis in this study. The result indicated that the overall seroprevalence recorded in the study were 13.6% in milk by RMT; 3.85% and 3.37% in serum by RBT and MAT respectively. Bamaiyi et al. (2012) conducted a study in Malaysia on the seroprevalence of Brucella melitensis in goats from the year 2000 till 2008 and the data was obtained from Department of Veterinary Services Malaysia. The result indicated that the overall seroprevalence was found to be 4.82% where Pulau Pinang state recorded the highest seroprevalence of *Brucella melitensis* (10.70%). Bamaiyi et al. (2012) also studied further on the seroprevalence and economic impact in eliminating zoonotic brucellosis among ruminant livestock in Melaka state of Malaysia. The result of the study showed that the odds of brucellosis in large ruminants (cattle/buffaloes) was significantly 1.6 times more compared to small ruminants in Melaka. For the total seroprevalence for brucellosis in Melaka was significantly higher in 2010 than previous years with a rate of 7.7%. There is still huge paucity of literatures on current seroprevalence of small ruminants (sheep and goats) brucellosis in Tropics regions focusing all states in Malaysia. The updated current seroprevalance data of all countries in tropic regions and states in Malaysia will aid in the control measures by strict monitoring and movement of animals.

Melioidosis is a contagious disease of humans and animals caused by Burkholderia pseudomallei bacterium (Elschner et al., 2012). Burkholderia pseudomallei is a facultative anaerobic, non-spore forming, gram-negative motile bacillus found on both soil surfaces and water (Hambali et al., 2018a). Melioidosis has an extremely wide host range where among domestic animals this disease is most commonly reported in sheep, goats, swine, lambs and cows (Sprague and Neubauer, 2004). The incubation period of acute Melioidosis varies from 1-21 days with an average of 9 days (Currie et al., 2000a). The clinical signs of Melioidosis exhibited in sheep and goats are similar. Experimentally infected sheep developed a severe febrile reaction accompanied by anorexia, lameness and thick yellow exudates from the nose and eyes. Experimentally and naturally infected sheep may show evidence of central nervous system involvement clinical signs which includes lameness, nystagmus, walking in circles, blindness, hyperaesthesia and mild tetanic convulsions (Sprague and Neubauer, 2004). The clinical signs observed in goats in the cases of Melioidosis are fever, anorexia, progressive emaciation, nasal discharge, salivation, coughing, lameness, paresis of the hind legs, abortion and severe mastitis (Sprague and Neubauer, 2004). Melioidosis has not only become a veterinary problem but can occasionally affects humans where this disease mainly affects susceptible persons who are directly in contact with contaminated wet soils (Currie et al., 2000b). The disease has variable expression fluctuating from localized abscess formation to circulated abscess, septicaemia, shock and probable death in humans (Jain et al., 2007). The lungs are the most affected organ by this disease where the affected lungs will exhibit abscesses and patients become acutely septicemic as reported in Malaysia, Singapore, Thailand, and Northern Australia (Cheng and Currie, 2005). Hongpiriyakul et al. (2014) conducted a study on seroprevalence of goat Melioidosis in southern Thailand and the results revealed the individual seroprevalence was 1.05% and herd seroprevalence was 7.81%. Hambali et al. (2018) have conducted a seroprevalence study involving small ruminant Melioidosis from selected farms in Selangor Malaysia. The study found the overall seroprevalence of Melioidosis among goats and sheep from these farms were 1% and 0%, respectively (Hambali et al., 2018). Another study in 2016 reported the overall seroprevalence of Melioidosis in Malaysian livestock were 5.7% with reactor rates in sheep and goats found were 13.6% and 2.6% respectively during a 10-year study period (Musa et al., 2016). This disease has current information on the prevalence and seroprevalence of Melioidosis in some states of Malaysia and continuous monitoring data needed for further control measures to make sure this disease is free from Malaysia and other Tropics region.

Caseous lymphadenitis (CLA) is a chronic wasting disease of goat and sheep populations internationally that contribute towards major economic significance (Abdullah et al., 2013). *Corynebacterium pseudotuberculosis* is the causative agent of CLA which belongs to the genus Corynebacterium, family corynebacteriaceae, suborder corynebacterianeae, order actinomycetales, subclass actinobacteriadae and class actinobacteria (de Sá Guimarães et al., 2011). CLA disease in small ruminants

are manifested in two main forms which are the external form characterized by infection of subcutaneous tissue and superficial lymph nodes (parotid, superficial cervical, mandibular, sub iliac, popliteal and mammary) and the internal form categorized by abscess progress towards the internal organs such as liver, lung, kidneys, uterus, spleen, and internal lymph nodes (mediastinal, lumbar and bronchial) (Williamson, 2001). In a study by Othman et al. (2016) stated that *Corynebacterium pseudotuberculosis* infections via intradermal, intranasal and oral routes in non-pregnant female goats showed significant changes in the reproductive hormones and cellular changes such as necrosis, congestion, inflammatory cell infiltration, and oedema that varied in severity in ovaries, uterus, and iliac lymph nodes of the infected female goats. This study has recognized that CLA infection could predispose towards infertility in affected small ruminant animals. However, there have been reported cases of CLA transmission to people from small ruminant where the incidence is rare. The gold standard diagnosis of CLA is isolation of the causative bacterium from visibly affected lymph nodes, followed by identification and morphological identification of the microorganism (Abdullah et al., 2013). Seyffert et al. (2010) carried out a study on seroprevalence of CLA in Brazilian goats where serum samples were collected from 676 goats involving 108 farms and the result showed that 78.9% of the sampled animals were tested seropositive for CLA. In Malaysia, Komala et al. (2008) had carried out a seroprevalence study of CLA in two districts of Perak, Malaysia where serum samples were collected from 579 small ruminants involving 8 farms and the result showed that 8.5% and 17% of the sampled animals were tested seropositive for CLA using Agar Gel Precipitation Test (AGPT) and Enzyme Linked Immuno Absorbant Assay (ELISA) respectively. Guimaraes et al. (2011) carried out a study to determine the seroprevalence of CLA involving slaughterhouse samples from Mines Gerais, Brazil where the result of the study showed that 43.7% of the samples were seropositive (Guimarães et al., 2011). From the review above it is known that CLA disease among small ruminants becoming an alarming and threat to the small ruminant livestock industry as this disease will lead to economic loss and compromise the welfare of the affected animal. The holistic information how severe the endemicity of this disease affecting all the countries in Tropics and particularly in Malaysia is still in grey area. Therefore, updated information on the current seroprevalance of this disease will aid in the control measures as this disease will cause huge production and economic loss in the small ruminant industry.

Contagious ecthyma (orf virus) also called contagious pustular dermatitis, infectious labial dermatitis, scabby mouth and sore mouth affecting small ruminants (Nourani and Maleki, 2006). The causative agent of this said disease is ORFV the kind species of the genus parapoxvirus, subfamily chordopoxviranae and family poxviridae (Abdullah et al., 2015). Contagious ecthyma can affect any ruminant species but it mainly affects goats and sheep species compared to other ruminants (Jesse et al., 2018). The incubation period of this disease varies from 3 to 4 days in sheep and goats and 3 to 11 days in humans (Degraeve et al., 1999). Affected animals show clinical signs of proliferative dermatitis in the lips, nostrils, gums, tongues and teats and development of pustules and scabs around the muzzle, buccal cavity, udder and between the toes (Abdullah et al., 2015). A study conducted by Jesse et al. (2018) on seroprevalence of small ruminant's contagious ecthyma infection based on IgM antibody against orf virus in Malaysia where 180 serum samples were collected from goats and sheep and the result showed 36.7% and 7.8% were positive for orf IgM antibodies. Daniela et al. (2016) carried out a study to determine the prevalence of major skin diseases in ruminants in Ethiopia and a total of 1296 samples from ruminants are enrolled in the study and the result revealed 3.47% of the samples were positive for Orf infection. Begum et al. (2016) studied the seroprevalence of Orf in Goats of Assam state in India and the result showed the overall seroprevalence of the study were 68.05%. Contagious ecthyma or ORFV infection in small ruminant farms become more prominent and holistic true seroprevalance and the severity of the infection need to be table out to have the true infection geographically particularly in Tropics region focusing in Malaysia.

Caprine Arthritis Encephalitis (CAE) is a severe and chronic distressing disease of small ruminants caused by a lentivirus that lead to substantial economic loss in the farm (Abdullah et al., 2018). CAE is caused by the virus belongs to the family of Retroviridae and subfamily Lentiviranae which usually causes long-lasting degenerative disease of many organ systems (Al-Ani and Vestweber, 1984). Caprine arthritis encephalitis virus (CAEV) can able to infect goats and sheep and other associated ruminants (Reina et al., 2006). CAEV will exhibit clinical signs such as prolonged synovitis and arthritis, demyelinising encephalitis, chronic interstitial pneumonia and indurative mastitis which contribute towards reduce in milk production (Lilenbaum et al., 2007). Most diseased goats or sheep continue asymptomatic but only minority develops clinical signs. Encephalomyelitis (progressive paresis) usually happens in kids aged between 2-6-month-old and older adult animals. Diagnosis of CAE infection in small ruminants can be based on the clinical signs, history and the laboratory test can be done to diagnose this disease by using nucleic acid detection techniques such as polymerase chain reaction (PCR) assays, southern blotting and in situ hybridization. Bandeira et al. (2009)

conducted a study on seroprevalence of CAEV in goats from Cariri region, Paraiba state of where the study showed the overall seroprevalence of CAEV was 8.2%. A study by Abdullah et al. (2018) stated that the seroprevalence of CAEV were 8.8% among 91 goats sampled from selected farms in Selangor, Malaysia. Lin et al. (2011) conducted a study on seroprevalence of CAEV infection in goats from western part of Thailand and a total of 1,129 serum samples were obtained from 74 randomly selected goat farms and the result revealed total of 67 goats were found seropositive with overall seroprevalence of 5.9% and true prevalence of 5.52% respectively. Waseem et al. (2015) Stated that there was 3.33% of Indian goats had positive seroprevalence of CAEV infection in Indian goats. CAEV infection in small ruminants also known as transboundary disease where the true picture of this disease needs to be study in detail in the Tropic regions particularly in Malaysia in order to have more emphasis in control and prevention strategy at small ruminant farms.

Goat Q fever is a zoonosis disease caused by *Coxiella burnetii* (*C. burnetii*) and is widespread in most places in the world except in New Zealand (Raoult et al., 2005). The term "Q fever" for query fever was proposed in 1937 by Edward Holbrook Derrick to define febrile sicknesses in slaughterhouse workers in Brisbane, Queensland, Australia (Maurin and Raoult, 1999). Sheep, goats and cattle are the traditional reservoirs of *C. burnetii* and the incubation period of this disease is approximately about 14-60 days where it usually varies about 20 days (Milazzo et al., 2001). *C. burnetii* infection mainly affects the reproductive system of the infected animals and the clinical signs exhibited by this infection are abortions, stillbirth, weak calf, metritis and infertility (Mohan et al., 2017). Schimmer et al. (2012) stated that the overall goat seroprevalence of Q fever was 21.4% and farm prevalence of Q fever was 43.1% on commercial dairy goat farms from Netherlands. Kennerman et al. (2010) conducted a study on the seroprevalence of Q fever in sheep from southern Marmara region of Turkey involving 42 flocks of sheep and the result showed 20% of sheep population were seropositive. Doung-Ngern et al. (2017) stated that the seroprevalence of *C. burnetii* infection among ruminant animals in Thailand are as follows where in cattle (4.6%) followed by goats (3.5%) and sheep (2.1%) from the 1,632 ruminant animals sera enrolled in this study and overall 64 (3.9%) of the ruminants were seropositive. (Browne et al., 2017) conducted a serosurvey of *C. burnetii* infection in dromedary camels in Likipia County of Kenya and in these study 334 camels from 9 herds were tested and the result showed 18.6% of camels were seropositive. (Carbonero et al., 2015) stated that the true seroprevalence and the herd prevalence of *C. burnetii* from dairy cattle farms in Ecuador were 12.6% and 46.9% respectively involving 2,668 dairy cows from 386 herds. de Oliveira et al. (2018) Conducted an investigation in determining the seroprevalance of C. burnetii in dairy goats with a history of reproductive disorders in Brazil and this study involves 321 dairy goats and the result revealed major cause of the reproductive disorder was due to C. burnetii infection where 55.1% of the tested animals were seropositive for *C. burnetii* in this investigation. Q fever has severe economic importance globally but there is shortage of information about current seroprevalence and prevalence of Q fever in Tropics especially in Malaysia. The status of Q fever prevalence in Malaysia is not yet clear and therefore is a need for further investigation in order to have the true prevalence of Q fever in all states of Malaysia.

Bluetongue was first described in 1905 among merino wool sheep in South Africa and the disease is caused by Bluetongue virus (BTV) a member of the genus orbivirus and this virus duplicates in wild and domestic ruminants affecting subclinical to fatal symptoms (Sperlova and Zendulkova, 2011). All ruminants are prone for BTV infection but the disease is most common in sheep where the incubation period is approximately a week with a range of 2-10 days and the typical clinical signs of this disease are fever, hyperptyalism, nasal discharge, hyperaemia, oedema and ulceration of the oral mucosa (Rushton and Lyons, 2015). A study was carried out by Joarder et al. (2013) to determine the seroprevalence of BTV infection among small ruminants in north eastern Indian state where a total of 313 small ruminants were screened and the result showed that the prevalence of BTV infection were 58.82% and 31.79% in sheep and goats respectively. Sharma et al. (2016) stated that the overall BTV seroprevalence among domestic ruminants which includes 133 cattle, 314 goats and 481 sheep from Grenada, Spain were 78.4%. Khezri et al. (2013) described that out of 756 samples collected from sheep in west and northwest regions of Iran, 40.87% of the samples were seropositive towards BTV infection where the rate of positivity in sheep in west and northwest were 46.10% and 33.75%, respectively. Recent study in Malaysia by Peter et al. (2018) on seroprevalence of BTV infection among 100 goats from selected small ruminant farms in Selangor, Malaysia found there were no (0%) seropositive towards BTV infection. Matos et al. (2016) carried out an epidemiology study of Bluetongue outbreak in a sheep flock in Brazil and the result showed seroprevalence of BTV infection was 80%. BTV infection among ruminants will cause severe economic loss globally and this disease is re-emerging in many countries and therefore current and updated seroprevalence and prevalence of BTV among ruminants in Tropics region especially in Malaysia need to be investigate critically as currently there is shortage of information about this infection.

Schmallenberg virus (SBV) infection is a newly emerging infectious disease of ruminants in Europe which spreads

through biting midges (Culicoides spp) and mosquitoes. The "Schmallenberg virus" is an enveloped, negative-sense, segmented, single-stranded RNA virus which belongs to the Bunyaviridae family of virus and cause diseases in ruminants (Saeed et al., 2001). To date the SBV-genome or specific antibodies were pre-dominantly noticed in ruminants specifically cattle, sheep, goats, bison, moose, alpacas, buffalos, horses, fallow deer, roe deer and red deer. This disease has no zoonotic potential (Ducomble et al., 2012). According to Garigliany et al. (2012) stated that in diseased adult ruminants with SBV might remain as asymptomatic or display undefined mild clinical signs which are fever, diarrhoea, reduced milk production and severe foetal malformations. The affected animals which include sheep, cattle and goats may exhibit clinical signs such as pyrexia, diarrhea, and drastic decreased milk production for milking animals and for reproductive system clinical signs of still births are observed in all three species as well as for congenital malformations. The severe reproductive effects can be seen in the affected dams are premature births, stillbirth or the birth of severely malformed offspring where congenital malformations including scoliosis, torticollis, kyphosis, lordosis, hydrocephalus, arthrogryposis, ankylosis, brachygnathi and hypoplasia of the cerebellum can be observed (Kitano et al., 1994). Abi-Rizk et al. (2017) conducted a study to determine the seroprevalence of Schmallenberg virus (SBV) infection among 750 Lebanese sheep in Lebanon and 122 animals were seropositive to SBV infection where the result indicated that herd-level and animal-level seroprevalence were 53.33% and 16.26% respectively. Helmer et al. (2016) conducted a detailed seroprevalence study of Schmallenberg virus infection in goats and sheep flocks in Germany where a total of 130 small ruminant flocks involving 3779 female sheep and goats (>1 year) in 13 German federal states were sampled during the survey. The result of the study revealed the herd seroprevalence of SBV infection for all 130 flocks tested was 53.3% with the median in a range from 0% to 100%. Elbers et al. (2012) described a study that was conducted to determine the seroprevalence of SBV infection among dairy cattle in Netherlands where the aim of the study is to detect past exposure to SBV among dairy cattle in Netherlands. In this study a total of 1,123 serum samples were collected from dairy cattle and were tested for antibodies against SBV by using a virus neutralization test and the seroprevalence detected was 72.5%. Knowledge specifically related to SBV infection is very limited or till date there are not any available data in the Tropics region particularly in Malaysia where the clinical cases involving reproductive system in ruminants need to be screen towards SBV infection. The observed suspected clinical cases involving reproductive system in ruminants need to be screen against SBV infection to avoid underestimation of the true rate of infection. Therefore, serodiagnostic studies are needed to detect past exposure to SBV in ruminant populations in the Tropics region particularly in Malaysia as till date there is no any study was done or carried out to determine the seroprevalence of SBV infection. There is a need for further investigation in Malaysia to indicate whether the disease in known in Malaysia as this disease is a newly emerging disease among ruminant livestock.

Therefore, it is important to have current seroprevalance status of common small ruminants' bacterial and viral diseases in tropics focusing in Malaysia where a holistic of current status essential to be study and known.

AUTHORS CONTRIBUTION

The content of the manuscript was read by all authors and recommended it worthy of publication.

CONFLICT OF INTEREST

The authors have no conflict of interests to declare.

REFERENCES

- Abdullah AA, Ismail MFB, Balakrishnan KN, Bala JA, Hani H, Abba Y, Nazariah ZA, Abdullah FFJ (2015). Isolation and phylogenetic analysis of caprine Orf virus in Malaysia. Virus Dis., 26: 255-259. https://doi.org/10.1007/s13337-015-0278-4
- Abdullah FFJ, Bitrus AA, Abba Y, Raju VN, Hambali IU, Peter ID, Norsidin JM (2018). Seroprevalence of small ruminant caprine arthritis encephalitis lentivirus among goats from selected small ruminant farms in Selangor, Malaysia. Vet. Wld., 11: 172. https://doi.org/10.14202/vetworld.2018.172-176
- Abdullah FFJ, Latif SNAA, Abba Y, Hambali IU, Bitrus AA, Peter ID (2018). Seroprevalence of Orf infection based on IgM antibody detection in sheep and goats from selected small ruminant farms in Malaysia. Comp. Clin. Path., 27: 499-503. https://doi.org/10.1007/s00580-017-2619-8
- Abdullah FFJ, Osman AY, Adamu L, Azri NA, Haron AW (2013). Caseous lymphadenitis in a goat. Vet. J. 52: 513-514.
- Abdullah FFJ, Osman AY, Adamu L, Azri NA, Wahid A (2013). Caseous lymphadenitis in a goat. Vet. J. 52: 513-514.
- Abi-Rizk A, Kanaan T, El Hage J (2017). Seroprevalence of Schmallenberg virus and other simbu group viruses among the Lebanese sheep. Open Vet. J., 7: 290-293. https://doi.org/10.4314/ovj.v7i3.15
- Agab H (1997). Clinical signs of animal brucellosis in Eastern Sudan. Rev. D'élevage Méd. Vét. Pays Trop. 50: 97-98.
- Al-Ani FK, Vestweber JGE (1984). Caprine arthritis-encephalitis syndrome CAE: a review. Vet. Res. Com., 8: 243-253. https://doi.org/10.1007/BF02214719
- Bamaiyi P, Hassan L, Siti-Khirani B, Adzhar A, Rachmat RFN (2010). The Seroprevalence of *Brucella melitensis* in goats of Malaysia from the year 2000 to 2008. 22nd Vet. Assoc. Malays. Congr. 4th Wildl. Soc. Zoo Wildl. Med. Int. Meet.

pp. 225-258.
- Bamaiyi PH, Abd-Razak NS, Zainal MA (2012). Seroprevalence and economic impact of eradicating zoonotic brucellosis in Malaysia: a case study of Melaka state of Malaysia. Vet. Wld., 5: 98-404. https://doi.org/10.5455/vetworld.2012.398-404
- Bandeira DA, de Castro RS, Azevedo EO, Melo LDSS, de Melo CB (2009). Seroprevalence of caprine arthritis–encephalitis virus in goats in the Cariri region, Paraiba state, Brazil. Vet. J., 180: 399-401. https://doi.org/10.1016/j.tvjl.2008.02.007
- Begum SS, Mahato G, Barman NN, Saleque A, Hussain M (2016). Seroprevalence of Orf in goats of Assam state of north-east India and immune response to a cell culture adapted Orf virus vaccine in goats. Indian Vet. J., 93: 29-30.
- Browne A, Fèvre EM, Kinnaird M, Muloi D, Wang C, Larsen P, Deem S (2017). Serosurvey of *Coxiella burnetii* (Q fever) in dromedary camels (*Camelus dromedarius*) in Laikipia County, Kenya. Zoon. Publ. Hlth., 64: 543-549. https://doi.org/10.1111/zph.12337
- Carbonero A, Guzmán LT, Montaño K, Torralbo A, Arenas-Montes A, Saa LR (2015). *Coxiella burnetii* seroprevalence and associated risk factors in dairy and mixed cattle farms from Ecuador. Prev. Vet. Med., 118: 427-435. https://doi.org/10.1016/j.prevetmed.2015.01.007
- Cheng AC, Currie BJ (2005). Melioidosis: epidemiology, pathophysiology, and management. Clin. Micro. Rev., 18: 383-416. https://doi.org/10.1128/CMR.18.2.383-416.2005
- Coelho AM, Coelho AC, Roboredo M, Rodrigues JA (2007). Case-control study of risk factors for brucellosis seropositivity in Portuguese small ruminants' herds. Prev. Vet. Med. 82: 291-301. https://doi.org/10.1016/j.prevetmed.2007.06.001
- Corbel MJ (2006). Brucellosis in Humans and Animals. Geneva: WHO Press.
- Currie BJ, Fisher DA, Anstey NM, Jacups SP (2000). Melioidosis: acute and chronic disease, relapse and re-activation. Trans. R. Soc. Trop. Med. Hyg., 94: 301-304. https://doi.org/10.1016/S0035-9203(00)90333-X
- Currie BJ, Fisher DA, Howard DM, Burrow JN, Lo D, Selva-Nnayagam S (2000b). Endemic melioidosis in tropical northern Australia: a 10-year prospective study and review of the literature. Clin. Infect. Dis., 31: 981-986. https://doi.org/10.1086/318116
- de Oliveira JMB, Rozental T, de Lemos ERS, Forneas D, Ortega-Mora LM, Porto WJN, Mota RA (2018). *Coxiella burnetii* in dairy goats with a history of reproductive disorders in Brazil. Acta Trop. 183: 19-22. https://doi.org/10.1016/j.actatropica.2018.04.010
- de Sá Guimarães A, Seyffert N, do Carmo FB, Pauletti RB, Ribeiro D, Lage AP, Gouveia AMG (2011). Caseous lymphadenitis: epidemiology, diagnosis and control. IIOAB J 2: 33-43.
- Degraeve C, De Coninck A, Senneseael J, Roseeuw D (1999). Recurrent contagious ecthyma (Orf) in an immunocompromised host successfully treated with cryotherapy. Dermatol., 198: 162-163. https://doi.org/10.1159/000018095
- Doung-Ngern P, Chuxnum T, Pangjai D, Opaschaitat P, Kittiwan N, Rodtian P, Padungtod P (2017). Seroprevalence of Coxiella burnetii antibodies among ruminants and occupationally exposed people in Thailand, 2012–2013. Am. J. Trop. Med. Hyg., 96: 786-790. https://doi.org/10.4269/ajtmh.16-0336
- Ducomble T, Wilking H, Stark K, Takla A, Askar M, Schaade L, Kurth A (2012). Lack of evidence for Schmallenberg virus infection in highly exposed persons, Germany, 2012. Emerg. Infect. Dis., 18: 1333. https://doi.org/10.3201/eid1808.120533
- Elbers AR, Loeffen WL, Quak S, de Boer-luijtze E, Van der Spek AN, Bouwstra R, Van Schaik G (2012). Seroprevalence of Schmallenberg virus antibodies among dairy cattle, the Netherlands, winter 2011-2012. Emerg. Infect. Dis., 18: 1065. https://doi.org/10.3201/eid1807.120323
- Elschner MC, Hnizdo J, Stamm I, El-Adawy H, Mertens K, Melzer F (2014). Isolation of the highly pathogenic and zoonotic agent Burkholderia pseudomallei from a pet green iguana in Prague, Czech Republic. BMC Vet. Res. 10: 283.
- Elschner M, Cutler S, Weidmann M, Butaya P (2012). *Burkholderia pseudomallei*: Melioidosis. BSL3 and BSL4 Agents: Epid micro and prac guidelines. John Wiley and Sons. https://doi.org/10.1002/9783527645114
- Galinska EM, Zagórski J (2013). Brucellosis in humans: aetiology, diagnostics, clinical forms. Ann. Agric. Environ. Med. 20: 2.
- Garigliany MM, Bayrou C, Kleijnen D, Cassart D, Jolly S, Linden A, Desmecht D (2012). Schmallenberg virus: a new Shamonda/sathuperi-like virus on the rise in Europe. Antivir. Res., 95: 82-87. https://doi.org/10.1016/j.antiviral.2012.05.014
- Guimarães AS, Carmo F B, Heinemann MB, Portela RW, Meyer RL, Gouveia AP, Gouveia AM (2011). High seroprevalence of caseous lymphadenitis identified in slaughterhouse samples as a consequence of deficiencies in sheep farm management in the state of Minas Gerais, Brazil. BMC Vet. Res., 7: 68. https://doi.org/10.1186/1746-6148-7-68
- Hambali IU, Abba Y, Bitrus A A, Peter ID, Jesse FFA, Balakrishnan T (2018). Seroprevalence of melioidosis in sheep and goats from selected small ruminant farms in Selangor, Malaysia. Adv. An. Vet. Sci., 6: 88-94. https://doi.org/10.17582/journal.aavs/2018/6.2.88.94
- Helmer C, Eibach R, Humann-Ziehank E, Tegtmyer PC Burstel D, Mayer K, Vogit K (2016). Seroprevalence of Schmallenberg virus infection in sheep and goats' flocks in Germany, 2012-2013. Vet. Med. Sci., 2: 10-22. https://doi.org/10.1002/vms3.14
- Hongpiriyakul S, Sirivongpaisal N, Suthummanon S, Kongkaew W, Penchamrat P (2014). Reduction of cost employing lean supply chain in the rubber glove industry. Int. Adv. Mat. Res., 844: 421-424. https://doi.org/10.4028/www.scientific.net/AMR.844.421
- Islam MA, Samad MA, Rahman AKMA (2010). Risk factors associated with prevalence of brucellosis in black Bengal goats in Bangladesh. Bangladesh J. Vet. Med., 8: 141-147. https://doi.org/10.3329/bjvm.v8i2.11198
- Jain VK, Jain D, Kataria H, Shukla A, Arya RK, Mittal D (2007). Melioidosis: a review of orthopaedic manifestations, clinical features, diagnosis and management. Int. J. Med. Sci., 61: 580-590. https://doi.org/10.4103/0019-5359.32926
- Jesse FFA, Latif SNAA, Abba Y, Hambali IU, Bitrus AA, Peter ID, Haron AW. Bala JA, Balakrishnan KN, Abdullah AA, Lila MAM (2018). Seroprevalence of orf infection based on IgM antibody detection in sheep and goats from selected small ruminant farms in Malaysia. Comp. Clin. Pathol. 27: 499-503.
- Joarde SN, Barkataki B, Halder A, Lodh C, Sarma D (2013). Seroprevalence of bluetongue in northeastern Indian State-Assam. Vet. Wld., 6: 196. https://doi.org/10.5455/

vetworld.2013.196-199
- Kennerman E, Rousset E, Gölcü E, Dufour P (2010). Seroprevalence of Q fever (coxiellosis) in sheep from the Southern Marmara Region, Turkey. Comp. Imunol. Micro. Infect. Dis., 33: 37-45. https://doi.org/10.1016/j.cimid.2008.07.007
- Khezri M, Azimi SM (2013). Seroprevalence of bluetongue disease in sheep in west and northwest provinces of Iran. Vet. Res. Forum. 4(3): 195-198.
- Kitano Y, Yamashita S, Makinoda K (1994). A congenital abnormality of calves, suggestive of a new type of arthropod-borne virus infection. J. Comp. Pathol., 111: 427-437. https://doi.org/10.1016/S0021-9975(05)80100-8
- Komala TS, Ramlan M, Yeoh NN, Surayani AR, Sharifah HSM (2008). A survey of caseous lymphadenitis in small ruminant farms from two districts in Perak, Malaysia-Kinta and Hilir Perak. Trop. Biomed., 25: 196-201.
- Krueger WS, Lucero NE, Brower A, Heil GL, Gray GC (2014). Evidence for unapparent *Brucella canis* infections among adults with occupational exposure to dogs. Zoonoses Publ. Hlth., 61: 509-518. https://doi.org/10.1111/zph.12102
- Lilenbaum W, de Souza GN, Ristow P, Moreira MC, Fráguas S, da Silva Cardoso VN, Oelemann W MR (2007). A serological study on Brucella abortus, caprine arthritis–encephalitis virus and Leptospira in dairy goats in Rio de Janeiro, Brazil. The Vet. J., 173: 408-412. https://doi.org/10.1016/j.tvjl.2005.12.003
- Lin TN, Ngarmkum S, Oraveerakul K, Virakul P, Techakumphu M (2011). Seroprevalence and risk factors associated with caprine arthritis-encephalitis virus infection in goats in the Western part of Thailand. Thai J. Vet. Med., 41: 353.
- Lopes B, Nicolino R, Haddad PA (2010). Brucellosis-risk factors and prevalence: a review. Open Vet. Sci. J. 4: 1. https://doi.org/10.2174/1874318801004010072
- Matos ACD, Balaro MFA, Guedes MIMC, Costa EA, Rosa JCC, Costa AG, Lobato ZIP (2016). Epidemiology of a Bluetongue outbreak in a sheep flock in Brazil. Vet. Ital. 52(3-4): 325-331.
- Maurin M, Raoult D (1999). Q fever. Clin. Micro. Rev., 12: 518-553. https://doi.org/10.1128/CMR.12.4.518
- Milazzo A, Hall R, Storm PA, Harris RJ, Winslow W, Marmion BP (2001). Sexually transmitted Q fever. Clin. Infect. Dis., 33: 399-402. https://doi.org/10.1086/321878
- Mohan V, Nair A, Kumar M, Dhaka P, Vergis J, Rawool D, Malik S (2017). Seropositivity of goats for coxiellosis in Bareilly region of UP India. Adv. Anim. Vet. Sci., 5: 226-228.
- Musa HI, Hassan L, Shamsuddin ZH, Panchadcharam C, Zakaria Z, Aziz SA (2016). Physicochemical properties influencing the presence of *Burkholderia pseudomallei* in soil from small ruminant farms in Peninsular Malaysia. *PLoS One*, 11: e0162348. https://doi.org/10.1371/journal.pone.0162348
- Nourani H, Maleki MOHSEN (2006). Contagious ecthyma: Case report and review. Pak. J. Bio. Sci., 9: 2543-2545. https://doi.org/10.3923/pjbs.2006.2543.2545
- Othman A, Abba Y, Jesse FFA, Ilyasu YM, Saharee AA, Haron AW, Lila MAM (2016). Reproductive, pathological changes associated with experimental subchronic *Corynebacterium pseudotuberculosis* infection in nonpregnant boer does. J. Path. (4624509): 7. https://doi.org/10.1155/2016/4624509
- Peter ID, Abba Y, Jesse FFA, Izzuddin A, Malek A, Bitrus AA, Hambali IU (2018). Seroprevalence of bluetongue antibodies among Goats in selected small ruminant farms in Serdang, Malaysia. Int. J. Liv. Res., 8(3): 39-44. https://doi.org/10.5455/ijlr.20180109033854
- Raoult D, Marrie T, Mege JL (2005). Natural history and pathophysiology of Q fever. Lancet Infect. Dis., 5: 219-226. https://doi.org/10.1016/S1473-3099(05)70052-9
- Reina R, Mora MI, Gloria I, García I, Solano C, Lujan L, Mamoun RZ (2006). Molecular characterisation and phylogenetic study of *Maedi visna* and Caprine Arthritis Encephalitis viral sequences in sheep and goats from Spain. Virus Res., 121: 189-198. https://doi.org/10.1016/j.virusres.2006.05.011
- Rushton J, Lyons N (2015). A review of the effects on production (2015). Vet. Ital. 51: 401-406.
- Saeed MF, Li L, Wang H, Weaver SC, Barrett AD (2001). Phylogeny of the Simbu serogroup of the genus Bunyavirus. J. Gen. Viro. 82: 2173-2181. https://doi.org/10.1099/0022-1317-82-9-2173
- Sagarasaeranee O, Kaewkalong S, Sujit K, Chanachai K (2017). Seroprevalence of brucellosis in small ruminants in Thailand, 2013. OSIR J., 9: 4.
- Schimmer B, Dijkstra F, Van der Hoek W, Wijers N, Rietveld A, Wijkmans CJ, Schneeberger PM (2012). The 2007–2010 Q fever epidemic in The Netherlands: characteristics of notified acute Q fever patients and the association with dairy goat f g. FEMS Imunol. Med. Micro., 64: 3-12. https://doi.org/10.1111/j.1574-695X.2011.00876.x
- Seleem MN, Boyle SM, Sriranganathan N (2010). Brucellosis: a re-emerging zoonosis. Vet. Micro. 140: 392-398. https://doi.org/10.1016/j.vetmic.2009.06.021
- Seyffert N, Guimarães AS, Pacheco LGC, Portela RW, Bastos BL, Dorella FA, Miyoshi A (2010). High seroprevalence of caseous lymphadenitis in Brazilian goat herds revealed by *Corynebacterium pseudotuberculosis* secreted proteins-based ELISA. Res. Vet. Sci., 88: 50-55. https://doi.org/10.1016/j.rvsc.2009.07.002
- Sharma RN, Beckford S, Tiwari K, Vinet E, Thomas D, de Allie C, Chikweto A (2016). Seroprevalence of bluetongue virus antibody in ruminants from Grenada. Open J. Vet. Med., 6(06): 99. https://doi.org/10.4236/ojvm.2016.66013
- Sperlova A, Zendulkova D (2011). Bluetongue: A review (2011). Vet. Med., 56: 430-452. https://doi.org/10.17221/3206-VETMED
- Sprague LD, Neubauer H (2004). Melioidosis in animals: a review on epizootiology, diagnosis and clinical presentation. J. Vet. Med., 51: 305-320. https://doi.org/10.1111/j.1439-0450.2004.00797.x
- Teshome D, Derso S (2015). Prevalence of major skin diseases in ruminants and its associated risk factors at University of Gondar Veterinary Clinic, North West Ethiopia. J. Vet. Sci. Technol., S13: 002.
- Teshome D (2016). Prevalence of Major Skin Diseases in Ruminants and its Associated Risk Factors at University of Gondar Veterinary Clinic, North West Ethiopia. J. Res. Dev., 4: 1.
- Waseem A, Pawaiya RVS, Singh R, Gupta VK, Rajukumar K, Mir MS, Aamir S (2015). Seroprevalence of caprine arthritis encephalitis virus infection (CAEV) in Indian goats. Indian J. Vet. Path., 39: 15-19. https://doi.org/10.5958/0973-970X.2015.00004.8
- Williamson LH (2001). Caseous lymphadenitis in small ruminants. Vet. Clin. North. Am. Food An. Prac., 17: 359-371. https://doi.org/10.1016/S0749-0720(15)30033-5