Prevalence of equine viral arteritis in Sudan

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\textbf{Article history:}
Received: 01 December, 2016  
Accepted: 01 December, 2016  
Available online: 17 February, 2017

\textbf{Keywords:}
Sudan, Equine arteritis virus, Prevalence, horses, donkeys, indirect ELISA

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\textbf{Abstract}
During the period of January to June 2016, the prevalence of equine arteritis virus (EAV) antibodies was investigated in adult horses (H) and donkeys (D) in five regions from Sudan, including, Khartoum, Atbara, Wad-Madani, Kurdufan and Nyala. Total of 352 serum samples (H=105 and D=247) examined with indirect ELISA; 63 (17.89\%) tested positive for EAV antibodies. The highest prevalence of the disease 23.48\% was recorded in donkey’s samples, compared to 4.76\% for horse’s samples. The disease was not detected in horses from Khartoum, Atbara and Kurdufan; all samples tested negative. Statistically, there is an association between infection and region (Chi-Square test \(P = 0.001\)). In conclusion, the results obtained confirmed the presence of EAV antibodies in horses and donkeys for the first time in Sudan. Further studies are needed to identify the circulating virus and the situation of the disease in other regions of Sudan.

\textbf{Citation:}

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Photon Ignitor: ISSN17846372D852017022017

1. Introduction
Equine viral arteritis (EVA) is a respiratory and reproductive disease of horses, caused by equine viral arteritis (EVA); which belongs to the genus Arterivirus in the family Arteriviridae of the order Nidovirales (Timoney and McCollum, 1993; Balasuriya, 2014; Snijder and Meulenberg, 1998). The disease was first isolated in 1953, from the lung of an aborted fetus after an extensive outbreak of respiratory disease and abortion on a Standard bred breeding farm near Bucyrus, Ohio, (Doll et al., 1957a; Doll et al.,1957b). Since then, the disease is distributed throughout the world; Serologic surveys have shown that EAV infection has occurred among horses in North and South America, Europe, Australia, Africa, and Asia.
Pho ton 476

(Timoney and McCollum, 1993; Echeverria et al., 2003). Some countries, such as Iceland, Japan and New Zealand, are apparently free of the virus (McFadden et al., 2013; Balasuriya, 2014). Exposure to the virus may result in clinical or unapparent infection depending on the virus strain, dose, age and physical condition of the animal and the environmental conditions. The clinical signs may include fever, anorexia, conjunctivitis, nasal discharge, dependent edema, abortion, and infrequently death in young foals (Doll et al., 1957; Timoney and McCollum, 1987). The disease is either transmitted horizontally by natural or artificial breeding of mares with EVA infected stallions or cooled or frozen contaminated semen with the virus. Transmission also could be via respiratory (aerosol), body secretion (urine, feces) or an indirect contamination of the tack and/or equipment shared among horses ((Timoney et al., 1987; Timoney and McCollum, 1993; Holyoak et al., 2008). Currently, diagnosis of EVA is based on a combination of virus isolation, viral nucleic acid or antigen detection and serology (Timoney and McCollum, 1993). Although, several enzyme-linked immunosorbent assays (ELISAs) have been described, and had high sensitivity and specificity (cELISA), the virus neutralization assay remains the gold standard for detection of serum antibodies (Cook et al., 1989; Cho et al., 2000; OIE, 2013; Pfahl et al., 2016). Although, the disease has direct economic losses due to abortion and/or disease and death in very young foals and decreased commercial value of persistently infected stallions (Timoney, 2000), there is no previous studies in EVA in Sudan and the situation of the disease in the country is unknown. For this, the present study is designed to investigate the prevalence of EAV antibodies in horse’s and donkey’s serum in selected regions in Sudan.

1.1 Objective of Research
To detect EAV antibody in equine serum in different localities in Sudan using indirect ELISA

1.2 Justification of study
Equine viral arteritis is an important viral disease it is a respiratory and reproductive disease of horses, the disease has direct economic losses due to abortion, clinical signs and death in very young foals and decreased commercial value of persistently infected stallions, the disease was reported in Africa, and this is first study of the disease in Sudan.

2. Materials and Methods

2.1. Work plan
During the period of January to June 2016, a total of 352 serum samples were randomly collected from apparently healthy adult horses (H) 105 and donkeys (D) 247. Five regions in Sudan were investigated (figure 1), including Khartoum (H 46, D 43), Nyala (H 48, D 40), Atbara (H 6,D 59), Wad Madani ( H 4,D 52) and Kurdufan (H 1,D 53). The samples were labeled and stored at -20°C till examined for EAV antibodies. The collected sera were tested using an indirect ELISA specific to EVA peptide; ID Screen kit (ID Vet Company, France). The test was performed in accordance to the manufacturer’s instruction. Results obtained were statistically analyzed using Statistical Packages for Social Science (SPSS) version 16, Software. The statistical significance between infection and region was determined using frequency and the chi-square analysis.

Figure 1: Regions of the study

3. Results
As shown in Table. 1, the prevalence of EVA in horses and donkeys population examined from five regions in Sudan was 17.89% (63/352). The highest prevalence of the disease 30.35% (17/56) was recorded in samples collected from Wad Madani followed by Kurdufan’s samples 27.77% (15/54); the lowest prevalence was in samples from Khartoum 10.11% (9/89). The results for the different species revealed that, 23.48% (58/247) of the donkey’s samples were positive, compared to 4.76% (5/105) for the horse’s samples. None of the horse samples (53) from Khartoum, Atbara and Kurdufan region was seropositive for EVA (Table 2). Statistically, there is an association between infection and region (Chi-Square test P = 0.001).
### Table 1: Prevalence of EVA antibodies in five regions in Sudan

<table>
<thead>
<tr>
<th>Region</th>
<th>Horses examined</th>
<th>Donkeys examined</th>
<th>Total samples examined</th>
<th>No. positive</th>
<th>Prevalence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum</td>
<td>46</td>
<td>43</td>
<td>89</td>
<td>9</td>
<td>10.11</td>
</tr>
<tr>
<td>Nyala</td>
<td>48</td>
<td>40</td>
<td>88</td>
<td>13</td>
<td>14.77</td>
</tr>
<tr>
<td>Atbara</td>
<td>6</td>
<td>59</td>
<td>65</td>
<td>9</td>
<td>13.84</td>
</tr>
<tr>
<td>Wad Madani</td>
<td>4</td>
<td>52</td>
<td>56</td>
<td>17</td>
<td>30.35</td>
</tr>
<tr>
<td>Kurdufan</td>
<td>1</td>
<td>53</td>
<td>54</td>
<td>15</td>
<td>27.77</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>247</td>
<td>352</td>
<td>63</td>
<td>17.89</td>
</tr>
</tbody>
</table>

### Table 2: Prevalence of EVA antibodies in donkeys and horses in five regions in Sudan

<table>
<thead>
<tr>
<th>Region</th>
<th>Horses</th>
<th>-ve</th>
<th>+ve</th>
<th>prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum</td>
<td>0</td>
<td>46</td>
<td>0</td>
<td>6.25</td>
</tr>
<tr>
<td>Nyala</td>
<td>3</td>
<td>45</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Atbara</td>
<td>0</td>
<td>5</td>
<td>9</td>
<td>15.25</td>
</tr>
<tr>
<td>Wad Madani</td>
<td>2</td>
<td>10</td>
<td>15</td>
<td>28.85</td>
</tr>
<tr>
<td>Kurdufan</td>
<td>0</td>
<td>1</td>
<td>15</td>
<td>28.3</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>100</td>
<td>58</td>
<td>4.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Donkeys</th>
<th>-ve</th>
<th>+ve</th>
<th>prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum</td>
<td>0</td>
<td>34</td>
<td>9</td>
<td>20.93</td>
</tr>
<tr>
<td>Nyala</td>
<td>10</td>
<td>30</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Atbara</td>
<td>9</td>
<td>50</td>
<td>15</td>
<td>15.25</td>
</tr>
<tr>
<td>Wad Madani</td>
<td>15</td>
<td>37</td>
<td>15</td>
<td>28.85</td>
</tr>
<tr>
<td>Kurdufan</td>
<td>15</td>
<td>38</td>
<td>15</td>
<td>28.3</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>189</td>
<td>58</td>
<td>23.48</td>
</tr>
</tbody>
</table>

### 4. Discussion

In the present study, the prevalence of anti- EVA antibodies was studied in five regions in Sudan including Khartoum, Nyala, Atbara, Wadmadani and Kurdufan. Using indirect ELISA, the results showed that, the prevalence of EVA in the samples tested was 63(17.89%); of which 5(4.76%) and 58(23.48%) were from horses and donkeys respectively. The highest prevalence of the disease 17(30.35%) was reported from Wadmadani 2(50%) in horses and 15(28.85%) in donkeys. Comparing the prevalence of the disease for the two species examined; donkeys samples from Wadmadani showed 28.85%, followed by 28.3%, 25%, 20.93% and 15.25% for the samples from Kurdufan, Nyala, Khartoum and Atbara respectively. Among the horse samples (53) from Khartoum, Atbara and Kurdufan region was seropositive for EVA; only 9.6% (5/52) from Nyala and Wadmadani tested positive. From the results obtained, the prevalence of EVA in donkeys is higher than that of horses; this could be due to high donkey’s population which is ten times the horse population of the Sudan, donkeys are used as a working animal, principally as pack animals or for draught work in transport or agriculture. The close contacts during work, the hard work and stress will facilitates the transmission of the virus. Similar results were obtained from Chile, South Africa and Turkey indicated the presence of EAV antibodies in the donkey’s population as 53%, 20.5% and 14.47% respectively (Moreira et al., 2016; Paweska et al., 1997; Yakup et al., 2008). Regarding horses, the result of the present study showed EVA seropositive in 4.76% of the horse samples from the five regions in Sudan which was lower than those obtained from some African countries; 7.46% in Algeria (Laabassi et al., 2014), 23.33% in Morocco (Lahlou, 1977) and ranged of between 8.75% and 17.23% in Tunisia (Ghram et al., 1994). During the sampling, no clinical signs of EVA were observed in horses and donkeys, all animals examined were apparently healthy. However, this does not mean that Sudan is not threatened by EVA. According to Timoney and McCollum, 1993, the majority of EAV infections are subclinical, and stallions who are infected with the virus may become persistently infected carriers. In the infected stallions, the virus is localized to the reproductive tract in a relatively high percentage and the infection is transmitted to susceptible mares through natural breeding or artificial insemination.

In many countries such as United States, Canada, France, Germany, The Netherlands, Hungary, Spain, the United Kingdom, Ireland, Mongolia, Argentina, Taiwan, South Africa, Jordan, Morocco, Tunisia, Brazil and Algeria, the disease is contagious and distributed in equine populations (Laabassi et al., 2014; Lahlou, 1977; Ghram et al., 1994; Paulo et al., 2013; Cullinan, 2003; Cardwell et al., 2002; de Boer et al., 1979; Echeverria et al., 2003; Eichhorn et al., 1995; Miszczak et al., 2012; Monreal et al., 1995; Pagamjav et al., 2011; St-Laurent et al., 1997; Stadejek et al., 2006; Szeredi et al., 2005; Chu and Ying, 2014; Abdelsalam et al., 2016). To the best of our knowledge, this is the first report of EVA among horses and donkeys in Sudan.

### Conclusion and Recommendations

Anti-EAV antibodies were detected for the first time in horses and donkeys in Sudan, and 17.89%
(63/352) of the samples tested positive. The prevalence of EVA was higher among donkeys compared to horses. None of the horse samples from Khartoum, Atbara and Kurdufan regions was seropositive for EVA. Further studies are needed to identify the circulating virus and the situation of the disease in other regions of Sudan.

**Research Highlights**

The presence of EAV antibody in equine serum in five regions in Sudan (Khartoum, Nyala, Atbra, Wadmadani and Kurdufan). Horse samples from Khartoum, Atbara and Kurdufan region was seronegative for EVA. Antibody for EVA was detected in donkey samples from all regions. The prevalence of EVA was higher among donkeys compared to horses.

**Limitations**

If there were enough funds, further studies are needed to identify the circulating virus and the situation of the disease in other regions of Sudan. Funding and policy aspects Indirect ELISA kit specific to EVA peptide was supplied by Veterinary Research Institute. The collection of samples and research publication were self-funded.

**Authors’ contribution and competing interests**

We declare there is no competing interest.

**Acknowledgement**

Our thanks extended to technical staff of virology department for their great help.

**References**


of the 2007 French EAV outbreak was linked to an EAV strain present in the semen of a persistently infected carrier stallion. Virology 423, 165–174.


