Seroprevalence of Peste des Petits Ruminants in Traditional Goats Reared in Northern Côte D’Ivoire

Gragnon B Guillaume\(^1\), *M’Bari K Benjamin\(^2\), Brou GK Gatien\(^3\), Coulibaly Adama\(^4\)

\(^1\)National Laboratory for Agricultural Development Support, BP 32 Korhogo, Côte d’Ivoire
\(^2\)Animal Biology, Production and Health Laboratory, Agropastoral Management Institute, Peleforo Gon Coulibaly University, BP 1328 Korhogo, Côte d’Ivoire
\(^3\)National Laboratory for Agricultural Development Support, BP 32 Korhogo, Côte d’Ivoire
\(^4\)Biosciences Training and Research Unit, Felix Houphouet Boigny University, 22 BP 582 Abidjan 22, Côte d’Ivoire

This study aims at determining the prevalence of Peste des Petits Ruminants (PPR) in goats reared traditionally in northern Côte d’Ivoire villages. For that, serum samples collected from 171 goats randomly selected from five localities in the Departement of Korhogo and tested the presence of anti-PPRV antibodies by a Competitive Enzyme-linked Immunosorbent Assay (c-ELISA). Overall, seroprevalence of PPR in the area was 36.26% (62/171). All the localities sampled had at least one PPR-positive animal. Age and sex of the animals were not significantly (p>0.05) associated with the infection; however, localities of sampled animals, showed significant (p<0.05) association with PPR virus-infection in goats. It is then concluded that there is high seroprevalence of PPR in traditional raised goats in northern Côte d’Ivoire. Therefore, vaccination campaigns against PPR are advocated to prevent the transmission and spread of PPR in the area.

Keywords: PPR, Seroprevalence, Traditional goats, Northern Côte d'Ivoire

INTRODUCTION

Peste des Petits Ruminants (PPR) is a highly contagious viral disease mainly affecting sheep and goats. However, several cases of PPR have been reported in other domestic and wild ungulates like Laristan sheep, gazelles (Dorcas, Arabian, Arabian mountain, Rheem, Thompson's), buffalo, springbuck, impala in captivity (Govindarajan et al., 1997; Abu Elzein et al., 2004; Diallo et al. 2007; Kinne et al., 2010). Cattle, camels and pigs can be infected by this virus, but there is little or no evidence of the disease associated with their infection (Khalafallaa et al., 2010; Schulz et al., 2018).

This disease is caused by a virus belonging to morbillivirus genre of paramyxovirus family (Kamissoko et al., 2013; OIE, 2016). Once introduced, the virus can infect up to 90% of a herd, lead to morbidity rates of up to 100% and the disease can kill 30 to 100% of infected animals (Sen et al., 2010; Chowdhury et al., 2014).

Described for the first time in 1942 in Côte d'Ivoire, PPR has subsequently spread to about 70 countries in Africa, the Middle East and Asia (Kamissoko et al., 2013; Ahaduzzaman, 2020). These regions regroup more than 80 percent of the world's sheep and goats populations, and more than 330 million of the world's poorest people rely on small ruminant livestock to live.

The tentatively diagnosis of Peste des Petits Ruminants is based on clinical, epidemiological and lesional characteristics of this disease. However, confirmation of this diagnosis is only obtained after laboratory analysis (Grech-Angelini, 2012; Balamurugan et al., 2014; Kamel and El-Sayed, 2019). These diagnosis tests are based on highlighting the presence of PPRV (antigens or DNA) or traces of its presence (anti-PPRV antibodies) in the serum. Many diagnostic tests like agar gel immunodiffusion test or AGIDT (Obi and Patrick, 1984), immunohistochemical staining such as immunoperoxidase (Saliki et al., 1994) or

*Corresponding Author: M’Bari K Benjamin, Animal Biology, Production and Health Laboratory, Agropastoral Management Institute, Peleforo Gon Coulibaly University, BP 1328 Korhogo, Côte d’Ivoire.

E-mail: mbariben@yahoo.fr
the immunocapture ELISA test or ICE (Libeau et al., 1994) can be used to confirm PPR. However, the most frequently used techniques are the polymerase chain reaction by reverse transcriptase or RT PCR (Forsyth et al., 2003; Balamurugan et al., 2006), the viral seroneutralization and the competitive immunoenzymatic technique or c-Elisa (Balamurugan et al., 2014).

In Côte d'Ivoire, the small ruminant herd is concentrated in the central, northern and southern regions of the country, which account for 40%, 37% and 15% respectively (MIPARH, 2003). PPR is regularly reported in all these areas and recently identified in the central and southern areas with an overall prevalence of 35.6% (Couacy-Hymann et al., 2015). Despite annual reports, no recent data are available on PPR in northern Côte d'Ivoire. Therefore, the aim of this study was to investigate the seroprevalence of the disease and assess the risk factors associated with age, sex, and breed localities in the north region.

MATERIAL AND METHODS

Study area

The sero-prevalence study was done in the Department of Korhogo. This administrative district is located between Latitude 8° 26 and 9° 50 North and Longitude 5° 25 and 6° 19 west. It is bounded on the north by Mali, on the south by the Region of Béré and on the east by the Regions Tchologo and Hambol and on the west by the Region of Bagoué. The climate is Sudanese, marked by an alternation of two seasons, a dry season and a rainy season. The dry season that runs from November to April is very marked by the harmattan between December and January and peaks of heat in March and April. This warm, dry wind of the harmattan blows from the north to east. The rainy season extends from May to October with maximum rainfall in July and August. Average temperatures vary between 24 and 33 °C. The hottest months are February, March and April with an average temperature of 36 °C and the coolest months are December and January with an average temperature of 16 °C. The average monthly humidity is 20%. The average annual rainfall is between 1100 mm and 1600 mm. The duration of insolation is 2000 hours per year (Guillaumet and Adjanohoun, 1971).

Study Design

A cross-sectional approach involving goats was conducted in five localities, namely Lataha, Napié, Korhogo, Karakoro and Tioro in the Department of Korhogo. Data was collected over a period of one month. It involved random sample collection from households following consent. Serological test and questionnaire survey were used as a tool for the determination of PPR prevalence and assess the risk factors associated with age, sex, and breed localities.

Sample Size and Sampling Procedure

The sample size for the study was determined as described by Ancelle (2017):

\[ n = z^2 \times p \left(1 - p\right) / m^2 \]

\[ n = \text{sample size} \]
\[ z = \text{confidence level (for a confidence level of 95%, } z = 1.96) \]
\[ p = \text{estimated proportion of the population with the characteristic (} p = 35.6\%) \]
\[ m = \text{tolerated margin of error (5%)} \]

Based on that, a total of 176 goats older than 3 months regardless of sex, were examined for PPR in the study area.

Blood samples were collected by jugular venipuncture of each animal using a 10 ml syringe and 21G needle following proper restraint. The blood samples were then labeled and transported on an ice pack to the laboratory where they were centrifuged for 15 min at 4000 rpm. During blood samples processing, 5 samples were removed from the batch due to their hemolysis. Clear sera were harvested into labeled cryovials and stored at -20°C in the biology laboratory, Pefeforo GON COULIBALy's University, until needed for further analysis. In total, one hundred and seventy one goats serum samples were analyzed using the c-ELISA kit.

Serological test

The competition ELISA for the detection of anti-PPRV antibodies (c-ELISA PPR), as described by the OIE (2013), was used to test the samples for PPR antibodies. The c-ELISA PPR test, presented in the form of a kit, was used according to the supplier's recommendations. The optical densities (OD) were read on the Multiskan EX spectrophotometer at the wavelength of 492 nm and was converted to percentage inhibition (PI) according to the formula:

\[ \text{PI} = 100 - \left[ \text{OD of the sample sera} / \text{OD of Monoclonal Control} \right] \times 100. \]

Serum with PI greater than 50% were considered positive.

Statistical Analysis

Data were entered into a Microsoft Excel 10 spreadsheet (Microsoft Corporation, Redmond, WA, USA) and analyzed using XLSTAT software (Addinsoft version gratuite 2019.3.2). Descriptive statistics were used and comparisons between qualitative data were made using chi-square tests to assess significance. A p-value of less than 0.05 was considered to be statistically significant. Intensities of the link between seroprevalence of PPR, sex, age and locality were calculated.
RESULTS AND DISCUSSION

Results

Of the one hundred and seventy one goats analysed, 133 (77.78%) female and 38 (22.22%) male goats. Ninety (26.32%) of the goats were less than 12 months old and 126 (73.68%) were more than 12 months old (Table 1).

Table 1: Sex, age and locality of goats tested for PPR antibodies in Northern Côte d’Ivoire

<table>
<thead>
<tr>
<th>Locality</th>
<th>Male number (%</th>
<th>Female number (%)</th>
<th>&lt; 1 year number (%)</th>
<th>≥ 1 year number (%)</th>
<th>Total Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karakoro</td>
<td>8 (26.67%)</td>
<td>22 (73.33%)</td>
<td>7 (23.33%)</td>
<td>23 (76.67%)</td>
<td>30 (17.54%)</td>
</tr>
<tr>
<td>Napié</td>
<td>3 (12%)</td>
<td>22 (88.00%)</td>
<td>6 (24.00%)</td>
<td>19 (76.00%)</td>
<td>25 (14.62%)</td>
</tr>
<tr>
<td>Tioro</td>
<td>7 (20.59%)</td>
<td>27 (79.41%)</td>
<td>11 (32.35%)</td>
<td>16 (67.65%)</td>
<td>34 (19.88%)</td>
</tr>
<tr>
<td>Lataha</td>
<td>9 (22.50%)</td>
<td>31 (77.50%)</td>
<td>12 (30.00%)</td>
<td>28 (70.00%)</td>
<td>40 (23.39%)</td>
</tr>
<tr>
<td>Korhogo</td>
<td>11 (26.19%)</td>
<td>31 (73.81%)</td>
<td>9 (21.43%)</td>
<td>22 (78.57%)</td>
<td>42 (24.56%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>38 (22.22%)</strong></td>
<td><strong>133 (77.78%)</strong></td>
<td><strong>45 (26.32%)</strong></td>
<td><strong>126 (73.68%)</strong></td>
<td><strong>171 (100%)</strong></td>
</tr>
</tbody>
</table>

Antibodies specific for PPR were detected in animals from all localities (Table 2). One hundred twenty four (62) of the 171 analyzed serum samples (36.26%) were positive for PPR antibodies. PPR seroprevalence was higher in females (30.10%) than in males (26.32%) but the difference of positivity rate was statistically no significant (P>0.05). Similarly, in relation to age group, the PPR infection prevalence in young goats (44.44%) was higher than adult goats (33.33%) one. The difference between age group serostatus was not significantly different (P>0.05). Furthermore, depending on the location of the sampled animals, the seroprevalence of ppr was variable, ranging between 21.43% and 64%. The PPR prevalence seemed to be higher in Napié (64%) than in Karakoro (40%), Lataha (37.5%), Tioro (29.41%) and Korhogo (21.43%). However, the PPR seroprevalences according to the localities are significantly different (P<0.05).

The intensity of the link between the studied variables and PPR prevalence is presented in Table 3. The links between PPR infection rate and goats sex on one hand and PPR disease and animal age group, on the other hand, are slight. The differences in prevalence between that of Napié and the other localities sampled were all signed except that of Karakoro (p> 0.05). However, goats from the locality of Napié were 6.5 times more likely to be infected with PPRV than those from Tioro (OR: 6.52 ; CI95%: 2.22-19.10) against 4.3 times more risk of infection than those de Korhogo (OR: 4.27 ; CI95%: 1.45-12.53). On the other hand, goats raised in the locality of Lataha present approximately 3 times less risk (OR: 2.96 ; CI95%: 1.07-8.20) of being seropositive for the anti-PPRV antibody than those coming from Napié.

Table 2: Seroprevalence of PPR in goat populations reared in five localities in Northern Côte d’Ivoire

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Number of sampled animals</th>
<th>Number of positive animals</th>
<th>Seroprevalence (%)</th>
<th>X²</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karakoro</td>
<td>30</td>
<td>12</td>
<td>40%</td>
<td>13.220</td>
<td><strong>0.010</strong></td>
</tr>
<tr>
<td>Napié</td>
<td>25</td>
<td>16</td>
<td>64%</td>
<td>0.285</td>
<td>0.148</td>
</tr>
<tr>
<td>Tioro</td>
<td>32</td>
<td>10</td>
<td>29.41%</td>
<td>2.089</td>
<td>0.183</td>
</tr>
<tr>
<td>Lataha</td>
<td>40</td>
<td>15</td>
<td>37.5%</td>
<td>0.183</td>
<td>0.183</td>
</tr>
<tr>
<td>Korhogo</td>
<td>42</td>
<td>9</td>
<td>21.43%</td>
<td>0.183</td>
<td>0.183</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>38</td>
<td>10</td>
<td>26.32%</td>
<td>1.771</td>
<td>0.183</td>
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<td>Female</td>
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<td>52</td>
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<td>1.771</td>
<td>0.183</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>45</td>
<td>20</td>
<td>44.44%</td>
<td>1.771</td>
<td>0.183</td>
</tr>
<tr>
<td>≥ 1 year</td>
<td>126</td>
<td>42</td>
<td>33.33%</td>
<td>1.771</td>
<td>0.183</td>
</tr>
</tbody>
</table>

Table 3: Association of risk factors (Locality, Sex, Age) and seropositivity of goats to PPRV in Northern Côte d’Ivoire

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR</th>
<th>CI95% (Min-max)</th>
<th>Yule’s Q</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Locality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karakoro vs Napié*</td>
<td>2.667</td>
<td>0.91-7.80</td>
<td>0.455</td>
<td>0.076</td>
</tr>
<tr>
<td>Korhogo vs Napié*</td>
<td>6.519</td>
<td>2.22-19.10</td>
<td>0.734</td>
<td><strong>0.000</strong>*</td>
</tr>
<tr>
<td>Tioro vs Napié*</td>
<td>4.267</td>
<td>1.45-12.53</td>
<td>0.620</td>
<td><strong>0.008</strong>*</td>
</tr>
<tr>
<td>Lataha vs Napié*</td>
<td>2.963</td>
<td>1.07-8.20</td>
<td>0.495</td>
<td><strong>0.037</strong>*</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male vs Female*</td>
<td>0.556</td>
<td>0.25-1.23</td>
<td>0.285</td>
<td>0.148</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year vs ≥ 1 year*</td>
<td>1.6</td>
<td>0.80-3.18</td>
<td>0.230</td>
<td>0.183</td>
</tr>
</tbody>
</table>

* denotes the reference risk factor
DISCUSSION

Out of 171 goat sera samples tested, 62 were positive for anti-PPRV antibodies, giving an overall seroprevalence of 36.26% in Korhogo department goats. This finding shows that more than 1/3 of goats reared in Korhogo department may be infected with PPR virus. The anti-PPRV antibodies slightly high prevalence found in this study may result from the fact that goats breed sampled is less susceptible to PPR infection and may have survived from this disease (Gopilo, 2005). This 36.26% prevalence is close to that reported from other African regions. Couacy-Hymann et al. (2015) had reported 35.6% prevalence in another region of Côte d'Ivoire, Hailegebreal (2018) reported 34% in Ethiopia and Dayhum et al. (2018) noticed 33% in Libya.

However, the prevalence (36.26%) is lower than the 43%, 61.8%, 62.8%, 69.4% and 70.2% reported respectively in Mauritania (El Arbi et al., 2014), in Nigeria (Abdalla et al., 2012; Saeed et al., 2010; Akpavie et al., 1997) and in Sudan (Shaibn, 2011). However, our findings were higher than those reported by Hailegebreal et al. (2018) in Ethiopia (29.2%), Sow et al. (2008) in Burkina Faso (23%), Munir et al. (2008) in Pakistan (25.6%) and Al-Afaleq et al. (2004) in Saudi Arabia (6.0%). As observed, the seroprevalence of PPR varied from country to country and even within the same country. This could be due to many factors such as farming systems, exploited breeds and the difference in climatic factors.

In our study, the prevalence of PPR higher in females (30.10%) than in males (26.32%) goats, however the difference in prevalence observed according to sex is not significant. It could be due to the higher number of females sampled. In other words, gender has no influence on the infection rate of PPR virus animals. Our finding was consistent with those of Dayhum et al. (2018) and Hailegebreal et al. (2018), who reported that in their respective studies the differences in prevalence observed between females and males were not statistically significant (p> 0.05) although anti-PPR antibodies were more prevalent in males respectively (34.7% versus 32.5%) and (29.6% versus 28.66%).

The present study showed that the prevalence of PPR appeared to be higher for PPR in young goats (44.44%) than in adult goats (33.33%). However, the difference in prevalence observed in the two age groups did not differ significantly (p> 0.05). This result corroborates that of the work of Rahman et al. (2016) in Bangladesh. These authors also noted in their study that the prevalence of PPR seemed higher in goats aged 4 to 12 months (42.30% for black bengal goats; 42.85% for Jamunapari goats) than goats aged more than 12 months (22.22% for black bengal goats; 25.00% for Jamunapari goats) with no significance between these values (p> 0.05). The trends observed in the prevalence in goats under 12 months of age and in older animals have been reported in numerous studies. This is the case of those conducted by sarker and Islam (2011) in Rajshahi district (Bangladesh) and Parvez et al. (2014) in Chittagong district (Bangladesh). Indeed, these authors have shown that the prevalence of PPR in young goats, in particular those aged 4 to 12 months is higher than that of older animals and that however, the differences in positivity rates were significant (p<0.05). Islam et al. (2012) also reported that the sensitivity of young animals (less than 12 months old) is very high compared to older animals. The discrepancies noted between our results and those of sarker and Islam (2011) and Parvez et al. (2014) could be due to the importance of their studied population.

The seroprevalence of PPR was found to be significantly higher at Napié (64%) when compared to the others localities of the study area, whereas the lowest prevalence level (21.43%) was obtained for Korhogo. This wide variation of PPR seroprevalence within the same area might be due to breeding systems.

CONCLUSION

This study showed the presence of Peste des Petits Ruminants (PPR) in the northern part of Côte d’Ivoire, with a prevalence ranging from 64% in Napié to 21.43% in Korhogo. This could explain the high mortalities of small ruminants that are generally observed in the rainy seasons in this region. To reduce these mortalities it is highly recommended to vaccinate small ruminants against the PPR. However, this study has concerned only goats and located in one department, further studies should be encouraged to identify the epidemiology of PPR in the northern part of the country.

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