



RESEARCH ARTICLE

LITERATURE REVIEW ON PESTE DES PETITS RUMINANTS IN CHAD

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ABSTRACT

Peste des petits ruminants (PPR) is a highly contagious, acute, transboundary viral disease of small ruminants, subject to mandatory reporting. The PPR pathogen belongs to the genus *Morbillivirus*, family *Paramyxoviridae*. The aim of this study is to produce a literature review on PPR in Chad. To this end, studies published between 1992 and 2025 were selected for this review. The databases consulted were Google Scholar and Google Search. The information retrieved was selected on the basis of its relevance to the manuscript. Studies have shown that the disease has been endemic in Chad since the virus was first isolated in 1995. The rate of infection with the PPR virus is higher in the sheep population (34.67 per cent) than in goats (27.37 per cent). The morbidity rate can reach 100% and the mortality rate 90%. The virus is transmitted mainly via the respiratory tract and through direct contact between sick and healthy animals. This disease acts as a barrier to the development of the livestock sector, as this sector plays an important role in job creation and income distribution in rural areas. The disease is characterised by the following symptoms: fever, lethargy, mouth ulcers, respiratory problems, eye and nasal discharge, stomatitis, diarrhoea and pneumonia with foul-smelling breath, often leading to death. At post-mortem, the lesions are characterised by erosions of the mucous membranes of the digestive tract, hypertrophy of the mesenteric lymph nodes, congestion of the lungs with one or more areas of hepatisation, and the presence of frothy exudate in the lungs. To combat this disease, Chad has drawn up and implemented the National Plan for the Control and Eradication of PPR by 2028. This literature review has highlighted the significant progress made in understanding PPR in Chad. However, gaps in knowledge remain, particularly regarding the progress of the National Policy for the Control and Eradication of PPR.

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INTRODUCTION

Peste des Petits Ruminants (PPR) is a highly contagious, acute, transboundary viral disease of small ruminants that is notifiable, and is considered one of the most damaging diseases affecting livestock populations (Fall, 2023; Fatima et al., 2018; Tounkara, 2018). Although it was first described in Côte d'Ivoire in 1942, its range has expanded to cover vast regions of Africa, from North Africa to Tanzania, via the Middle East, and it is also widespread in countries ranging from Central Asia to South and East Asia (Kumar et al., 2014). PPR currently affects nearly 76 countries in Africa, the Middle East and Asia (Balamurugan et al., 2021). It is characterised by fever, eye and nasal discharge, stomatitis, diarrhoea and pneumonia with foul-smelling breath, leading to death. According to the World Organisation for Animal Health (OIE), it can result in high rates of morbidity and mortality, reaching up to 100 per cent and over 90 per cent respectively in susceptible herds. According to Lefèvre & Diallo (1990), death

occurs between 5 and 10 days after infection, and convalescing animals develop strong immunity, presumably lasting for the animal's entire productive life. In Chad, the disease has been endemic since the virus was isolated by Bidjeh and Antipas (2015). The Food and Agriculture Organisation of the United Nations (FAO) and the World Organisation for Animal Health (OIE) have approved the Global Strategy for the Control and Eradication of PPR (PPR GCES) and launched the Global Eradication Programme for PPR (PPR GEP), to eradicate the Small Ruminant Peste virus (PPRV) by 2030 (Tenuche et al., 2023). In the run-up to the global and pan-African strategies for the control and eradication of PPR, Chad officially requested technical support from the AU-BIRA to help draw up its national strategy for the control and eradication of PPR. Consequently, the FAO and CEBEVIRHA stepped in to assist Chad in formulating the previous strategy, which was adopted in August 2017. This document was revised and approved on 7 November 2022 during a workshop held as part of the PRAPS project, the Regional Project to Support Pastoralism in the Sahel (MEPA, 2023).

Given that vaccination is the key element in the control and eradication of PPR, as highlighted by the FAO and the OIE in 2015, Chad has been running annual PPR vaccination campaigns since 2017 with the support of various technical and financial partners. The aim is to achieve vaccination coverage of at least 80 per cent of the sheep and goat population to ensure effective herd immunity (MEPA, 2023). This was followed by two further mass vaccination campaigns in 2019 and 2023. During the most recent mass vaccination campaign against PPR, 9,485,373 small ruminants were vaccinated across the whole country (MEPA, 2023). This article reviews the available literature on the pathogen, the epidemiology of PPR, the impact on small ruminant herds, the diagnosis, and the PPR control and eradication strategy implemented in Chad by the Ministry of Livestock and Animal Production. These factors are essential to improving our understanding of the current situation regarding this disease.

METHODOLOGY

Studies published between 1992 and 2025 were selected for this review. The databases consulted were Google Scholar and Google Search. The information retrieved was selected on the basis of its relevance to the manuscript, following a process inspired by the PRISMA flowchart. This selection process enabled us to eliminate irrelevant documents by applying the inclusion and exclusion criteria we had previously defined. With regard to the source of information, scientific articles, books or book chapters, theses and dissertations were included. Non-scientific reports were excluded. In terms of subject relevance, studies that did not directly address the subject or only mentioned it superficially were excluded. The relevance of the documents findings was also taken into account. Indeed, documents whose results were unusable, irrelevant or inconsistent were excluded. The selection process took place in two phases: an initial phase to exclude documents that were clearly irrelevant, focusing on titles, abstracts and keywords; followed by a second phase in which we read the shortlisted documents in full. The key search terms used were: small ruminants in Chad, Peste des Petits Ruminants, pathogen, epidemiology, diagnosis, and PPR control and eradication strategy.

RESULTS AND DISCUSSION

Main breeds of small ruminants raised in Chad: In Chad, small ruminants comprise sheep and goats. Owing to their high level of adaptability, ease of management and socio-cultural significance, they are reared in almost all regions of the country (Amine & Padire, 2025). Several breeds of sheep and goats exist in Chad. Among the sheep are the Arab sheep, the Fulani sheep, the Kababich sheep, the Mayo-Kébbi sheep, and the Kirdimi or Kirdi sheep. Goats belong to two breeds: The Sahel goat and the southern Kirdi goat. In 2022, the small ruminant livestock population in Chad was estimated at 91,522,170 head, including 45,081,553 sheep and 46,440,617 goats (MEPA, 2023).

Description of the PPR virus: The PPR virus belongs to the genus *Morbilivirus*, family *Paramyxoviridae* (Zaidiet al, 2024; Fayyad, and Alzuheir, 2024). For a long time, this virus was considered to be a mutant of the rinderpest virus that had adapted to small ruminants and lost all pathogenicity for cattle. It was only following in-depth studies that some

researchers concluded that they are two distinct entities (Bidjeh et al, 1995). The PPR virus is highly polymorphic in its morphology, although it is generally roughly spherical (Fall, 2023). Its size is highly variable, ranging from 150 to 700 nm, with the majority of particles measuring 500 nm (Tounkara, 2018). It consists of a helical nucleocapsid surrounded by a lipoprotein envelope. Owing to this envelope, the virus is destroyed by lipid solvents and is highly fragile, particularly in the external environment (Fall, 2023). Genotypic classification of the PPRV has identified four lineages. Lineages I and II are restricted to West Africa; lineage III is common to East Africa and parts of the Middle East; and lineage IV has historically been predominant in the Middle East. The reasons for its dominance are still poorly understood.

The virus is transmitted primarily via aerosols between animals (Fall, 2023), mainly through inhalation of aerosols and direct contact with infectious material (Ugochukwu et al., 2019; Bouziane et al., 2025). Transmission can also occur via the oral route, following the ingestion of contaminated feed, pasture or water (Fayyad and Alzuheir, 2024). In young animals, the disease is transmitted through suckling milk from their infected mothers (Zaidi et al., 2024). There is no evidence of vertical transmission of PPR via the placenta. However, evidence of the presence of viral RNA in *Culicoides* species raises the question of vector-borne transmission of PPR (Bouziane et al., 2025). Animal movement associated with trade or pastoralism is a significant factor in the transmission and cross-border spread of PPR, as its spread is very closely linked to regional movements of live animals (Ilyes, 2022). The period of risk for PPR is between January and April, with a peak observed in February. The main risk factors for PPR are the environment in which the farm is located, the introduction of new animals onto the farm, the gathering of animals at grazing or watering points, animals straying, and transhumance, with respective percentages of 54%, 33%, 27%, 22%, and 7% (Ouagal et al., 2018; Loul et al., 2020; and Amine and Padire, 2025).

Symptoms: PPR is generally characterised by fever, depression, mouth ulcers, respiratory problems (Loul et al., 2020), eye and nasal discharge, stomatitis, diarrhoea and pneumonia with foul-smelling breath, and often death (Fatima et al., 2018; MEPA, 2023). PPR is a disease that affects both the digestive and respiratory systems. The disease can manifest in various clinical forms depending on the species affected, as well as on factors such as breed, age or individual immune status. Four clinical forms of the disease are usually distinguished. The infection progresses rapidly, with an incubation period of 2 to 6 days. Pregnant females may abort. (Kumar et al., 2014; Chaimae and Zohra, 2021; and Kock, 2022). In an experimental study carried out in Chad by Alfaroukh et al. (2018) on local breeds of sheep and goats, the results showed that in Kirdimi goats, the incubation period of the virus is very short (3–6 days) in inoculated animals. The characteristic signs of PPR were observed throughout this experiment. The temperature rises rapidly from 39.8°C to 41.3°C and the animal remains feverish for several days. This is followed by nasal discharge, which is initially serous and later becomes mucopurulent. The presence of necrotic ulcerative stomatitis in some animals, unilateral or bilateral tearing, profuse and sometimes bloody diarrhoea generally appearing 4–5 days after the onset of fever, weight loss and increased respiratory rate have been observed. In Sahelian goats, a fever was observed in only 3 animals. Sahelian goats did not display the clinical symptoms characteristic of PPR. Of

18 goats, 9 exhibited at least one clinical sign, of which 5 died as a result of the disease. Generally speaking, the symptoms observed in these animals were much milder than those observed in Kirdimi goats. There does indeed appear to be a difference in susceptibility between the two goat breeds. In Kirdimi sheep, a fever was observed in 11 of the 15 animals, with some displaying clinical signs characteristic of PPR, and 7 animals died. Among Sahelian sheep, out of 15 animals used, 12 showed an elevated temperature, of which 4 died. Death generally occurs within 14 days of infection, 5 to 7 days after the onset of fever, often during a phase of hypothermia (Fall, 2023).

Lesions and Diagnosis: At post-mortem, the carcass is emaciated and in poor condition. Organic changes are observed in the digestive tract, with lesions in the oral cavity: these consist of congestive, ulcerative and necrotic stomatitis affecting the gums, the inner surface of the lips, the cheeks, the tongue and the pharynx (Fall, 2023); as for the internal organs, post-mortem lesions observed include congestion of the lungs and the gastrointestinal tract, in particular discontinuous streaks of congestion (zebra-like streaks or zebra-like marks), congestion and hypertrophy of the retropharyngeal and mesenteric lymph nodes, as well as linear haemorrhages in the intestinal mucosa and splenomegaly (Ugochukwu, 2019). The lesions observed by Alfaroukh et al. (2018) show that erosions of the oral mucosa are particularly localised on the tongue, the inner surface of the lips, the gums and the palate. Ulcerative erosions are also noted in the oesophagus of Kirdimi goats. The intestine appears purplish-red. The mesenteric lymph nodes are enlarged, sometimes black in colour and soft in consistency. The intestinal mucosa is severely congested and sometimes petechial. In the respiratory system, in addition to rhinitis and serous or mucous laryngitis, one or more areas of red (rarely grey) hepatisation are often observed at the tips of the apical and cardiac lobes. The tracheobronchial and mediastinal lymph nodes are enlarged and sometimes black. The trachea is often coated with mucus. A foam-like substance oozes from the lung tissue. The lungs are congested.

Nasal swabs are considered the best sample for the early diagnosis of the disease. Faecal samples may represent a better alternative to conventional ocular or nasal swabs for monitoring the virus in wildlife and livestock (Fayyad & Alzuheir, 2024). Traditionally, diagnosis of PPRV relied on serological techniques and the isolation of the virus from samples through its cultivation in adaptable cell lines (Ashraf et al., 2017). In 2022, the OIE drew up a list comprising all types of tests available for the diagnosis of PPR. Tests carried out on individual animals or populations may serve various purposes, such as confirming the diagnosis of clinical cases, determining infection status for trade and/or movement, estimating infection or exposure prevalence (surveillance), or verifying post-vaccination immune status (surveillance). Agar gel immunodiffusion (AGID) and counter-immune electrophoresis (CIEP) are relatively simple diagnostic methods suitable for small-scale field centres and basic laboratories. In live animals: take swabs for real-time RT-PCR testing, and isolate and sequence positive samples. Mohammed & Abdelkader (2019) reported that, on post-mortem examination, the observation of congestive and erosive lesions on various mucous membranes, as well as bronchopneumonia lesions, helps to confirm the diagnosis. Not all of these lesions are present in a single animal, hence the need to diagnose all sick animals in the herd.

Peste des Petits Ruminants in Chad: Although Peste des Petits Ruminants is widespread in Africa, in Chad the disease was not diagnosed until the early 1990s, and the PPR virus was not first isolated until 1995. Indeed, the study conducted by Bidjeh et al. (1995) succeeded in isolating the virus, and clinical cases characteristic of PPR were observed in Sahelian goats, which are considered to be relatively resistant to this virus. Although the virus could not be isolated from the first outbreaks in 1993, serological screening using a competitive ELISA test on 475 serum samples collected in the epidemic zone revealed a prevalence of 34%. Sheep and goats are considered the main hosts of the PPR virus (Fayyad and Alzuheir, 2024). In endemic countries, outbreaks of PPR in the same area occur every three years. This is because the virus can only be sustained through new susceptible hosts (such as young animals that have lost their maternal antibodies, or animals in transhumant herds or newly purchased animals that have not previously been exposed to the disease); those that have recovered from the disease are protected for life (Toukara, 2018). The study conducted by Amine & Padire (2025) in two provinces of the country found a seroprevalence of PPR infection of $21.4\% \pm 0.739$ out of 500 serum samples in the general study population.

Bidjeh et al. (2015) reported that in Chad, the rate of PPR virus infection is higher in the sheep population (34.67 %) than in the goat population (27.37 %). The morbidity rate can reach 100% and the mortality rate 90% (MEPA, 2018; Fayyad and Alzuheir, 2024). Morbidity and mortality rates are lower in endemic areas and in adult animals than in young animals. Further studies have established that the disease is more severe in goats than in sheep (Fayyad and Alzuheir, 2024). In Chad, the seroprevalence by small ruminant species, based on risk factors, is as follows (Ouagal et al., 2018): By species: 57.1% for goats and 48.3% for sheep. By sex: 42.7% for billy goats and 60.8% for nanny goats; 37.3% for rams and 49.8% for ewes. With regard to farming practices, the prevalence in sedentary herds is 48.0%, whilst in transhumant herds it is 50.5%. According to Alfaroukh et al. (2018), dwarf goats from Chad (kirdimi) are significantly more susceptible to PPR than goats from the Sahel. Sahelian sheep appear to be more susceptible to PPR than Sahelian goats. West African dwarf goats – the Lagunaire, Kirdi and Djallonké breeds are significantly more susceptible than the large Sahelian breeds (Toukara, 2018). Age is also a factor, and young animals aged 3 to 18 months appear to be more severely affected than adults or young animals that are suckling. Furthermore, climatic factors are significant, and outbreaks are more frequent during the rainy season or the cold dry season (Lefèvre and Diallo 1990). With regard to wildlife, Toukara (2018) reports that wild small ruminant species from various families of ungulates, including the subfamilies *Gazellinae*, *Tragelaphinae* and *Caprinae*, may also be affected and exhibit high rates of morbidity and mortality.

Impact of PPR on small ruminant farms: Nationally, losses caused annually by this disease are estimated at US\$2.1 billion (MEPA, 2018). Furthermore, small ruminants and their products are traded internationally, particularly in Africa and the Middle East. PPR therefore affects export earnings and leads to supply shortages. The inability of families, communities and institutions to anticipate, mitigate or overcome the impacts of PPR is likely to undermine development efforts at national and regional levels, as well as cause a reversal of progress, undoing decades of gains.

(MEPA, 2018). PPR acts as a brake on the development of the livestock sector, as this sector also plays an important role in job creation and income distribution in rural areas, where it is sometimes the sole source of income for the most disadvantaged populations and the only means of utilising semi-arid areas (MEPA, 2023).

National Plan for the Control and Eradication of PPR: PPR is one of the priority diseases monitored by the National Disease Surveillance System in Chad. No national mass vaccination campaign against this disease had been carried out prior to 2017 (Mahamat et al., 2018). Given its socio-economic significance, the eradication of PPR has been targeted for 2030. To achieve this, global, continental, regional and national control and eradication strategies have been developed (Mahamat et al., 2018). As a precursor to these various strategies, Chad has established the National Strategic Plan for the Control and Eradication of Peste des Petits Ruminants (PNS-PPR). This National Plan stems from the regional strategy for the control and eradication of PPR in Central Africa. Both strategies are aligned with the global objective of eradicating PPR by 2030 (MEPA, 2023). Vaccination is a key component of PPR control and eradication. The National Strategic Plan for the Control and Eradication of PPR was revised and approved at a workshop on 7 November 2022. The revised document sets out a target for the eradication of the disease by 2028. It is divided into four stages:

Stage 1, 2022: This will enable the veterinary authorities in Chad to expand their knowledge of the current epidemiological situation of the disease in Chad (infected regions, prevalence rates by region, national prevalence rate, etc.), notably through the analysis of the results of the latest epidemiological surveys carried out under PRAPS II and PREPAS. Stage 2, 2023–2024: During this phase, PPR control activities based on vaccination will be expanded. The strategy adopted is to gradually build up the capacity to implement mass vaccination campaigns against diseases affecting small ruminants. During this period, sero-monitoring surveys – also planned under PRAPS II and the REPER project – will enable a precise assessment of the effectiveness of the campaigns carried out. Stage 3, 2025–2028. In this phase, vaccination campaigns will be extended to the whole country. The aim is to vaccinate and tag as many eligible animals as possible during the three years of this phase. During this period, serological monitoring surveys will continue. Stage 4, 2028–2029: This period will be devoted to demonstrating, through serological assessments, that there are no longer any clinical cases of the disease or viral circulation. However, a vaccination programme targeting young females will be organised during the two years of this stage. In 2030, Chad could begin the process of applying to the OIE for PPR-free status. To achieve control of the disease by 2030, Chad, through the Ministry of Livestock and Animal Production (MEPA), has been organising annual mass vaccination campaigns for small ruminant herds across all 23 provinces of the country since 2017, as part of the PNS-PPR. These campaigns are carried out with the support of its technical and financial partners, namely the Regional Programme to Support Pastoralism in the Sahel (PRAPS) (MEPA, 2023). To this end, for the 2022–2023, 2023–2024 and 2024–2025 vaccination campaigns, in response to the needs expressed by the Directorate-General for Veterinary Services (DGSV), the PRAPS-2 Chad project supplied 11 million, 16 million and 22.05 million doses of PPR vaccine respectively. For the 2025–2026 vaccination campaign, the

government plans to vaccinate more than 80 per cent of the eligible livestock population, having recently placed an order for a further 22,050,000 doses. The study conducted by Bechir et al. (2025) demonstrated the high efficacy of vaccination campaigns against PPR, with a post-vaccination seroconversion rate of 73.56 %, which is significantly higher than the rates set by the national strategy.

CONCLUSION

This literature review has highlighted the significant progress made in understanding PPR in Chad. However, gaps in knowledge remain, particularly regarding the progress of the National Policy for the Control and Eradication of PPR and the conduct of sero-monitoring surveys to identify areas with low immune response where vaccination efforts will be rigorously intensified. Through continued research, potential risk factors and the origin of the disease in Chad will be identified. Combined with the results of the National Plan for the Control and Eradication of PPR, understanding these factors will contribute to the control and, ultimately, the eradication of this disease. In light of the findings of this study, several areas of research warrant further investigation in order to eradicate PPR in Chad:

- To conduct advanced molecular biology research to identify the strain(s) responsible for PPR in Chad, with a view to establishing its origin.
- Conduct research to identify the reservoirs of PPR within the wildlife population and the role of biting-sucking insects in the infection;
- Further research is essential to develop rapid and more sensitive diagnostic tests for PPR.

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