Research Article

Outbreaks of PPR-FMD among Sheep and Goats in Hail, Saudi Arabia

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Abstract | *Peste des petits* ruminants (PPR) is a viral disease which primarily affects small ruminants, causing significant economic losses for the livestock industry. Clinical investigation was carried out during the suspected outbreaks of PPR/FMD in sheep and goats in Hail. Saudi Arabia. During the outbreaks 271 (20.6%) died out of 648 (49.3%) of affected animals, the overall morbidity in goats (33.3%) was higher as compared to sheep (12.3%), with a case fatality rate in goats reached 74.69% in the 2nd outbreak. Affected animals exhibited fever, stomatitis, mucopurulent to bloody nasal/ocular discharges, watery to bloody diarrhea and lameness. The major gross lesions were erosive stomatitis, hemorrhages in lung, liver, abomasum, small and large intestine. PPRV NP was detected in sheep (n=20) and goats (n=18), anti-PPRV NP was also detected among sheep and goats (n=162) by ELISA, 3ABC-FMD enzyme immunoassay were positive (n=6) when ovine sera were tested. The study revealed that PPR-FMD viruses were circulating in the region and warrants proper control measures.

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Introduction

Peste des petits ruminants (PPR) is a highly contagious often fatal viral disease of domestic and wild ruminants caused by PPR virus (PPRV) of the family *Paramyxoviridae* (Venkataramanan et al., 2005; Diallo et al., 2007; Banyard et al., 2010). PPR is transmitted by direct contact with infectious animals shedding the virus in both ocular-nasal discharges and in fecal matter (Munir et al., 2013). Fomite contamination with the virus from infected animals such as feed troughs and bedding is an additional source of infection (Lefèvre et al., 1990). The disease is characterized by pyrexia, purulent mucous nasal/ocular discharges, necrotizing and erosive stomatitis, gastroenteritis, diarrhea and bronchopneumonia (Balamurugan et al., 2014). Geographically, PPR has been reported in the Middle East, South Asia, China and sub-Saharan Africa (Shaila et al., 1996), serological evidence has been documented in Uganda, Sudan, Tanzania and Ethiopia (Waret-Szkuta et al., 2008; Luka et al., 2011). In Saudi Arabia, it was first reported in 1990 (Abu Elzein et al., 1990), the disease has since spread to different parts of the country (Housawi et al., 2004; Al-Afaleq et al., 2004; Boshra et al., 2015; Mahmoud et al., 2016, 2017).

Foot and mouth disease (FMD) is one of the most serious transboundary animal diseases. It is a highly contagious viral disease, and may have rapid and unanticipated national and international spread and is characterized by fever and vesicular eruption in the mouth and on the feet and teats (Radostits et al., 2000; Alexandersen, 2005; Wernery and Kinne, 2012). The virus was classified under the genus *aphthovirus* of the family *Picornaviridae* (Radostits et al., 2000). Mild or unapparent infections in sheep and goats may hinder control programs (Kitching and Hughes, 2002). Outbreaks of FMD was repeatedly documented among sheep and goats in various regions of Saudi Arabia (Hafez et al., 1993a; Hafez et al., 1993b; Hamada et al., 2008; Alsayeqh and Fathi, 2012).

The current investigation was aimed at describing the pathology and epidemiology of PPR-FMD infections in four mixed flocks (sheep, goats and camels) in Hail district. Saudi Arabia.

Materials and Methods

Epidemiological investigation

Outbreaks occurred among four mixed farms (sheep, goats and camels) in Hail district. Saudi Arabia were investigated during February to May 2016 (Table 1).

Sample collection

Nasopharyngeal, ocular and rectal swabs (n=46) were collected from affected goats (n=18), sheep (n=20) and clinically healthy camels (n=8). Sera were collected from goats (n=38), sheep (n=124) and camels (n=8), samples were preserved at 4°C until tested.

P.M Examination

Autopsy were performed on recently dead sheep (n=26) and goats (n=20), gross pathology was recorded.

PPR-NP ELISA

Immune capture ELISA kits for detection of PPR-NP antigen was used (ID Screen®PPR Antigen Capture- CIRAD, Montpellier, France) according to the manufacturer's protocol. The absorbance was read at 450nm with an ELISA reader (BioTek ELX800). The results were calculated as sample positivity (S/P%) and the level of PPRV was expressed as percentage of the positive control. If S/P >20% it was considered negative, S/P ≥20% it was considered positive.

Anti-NP ELISA

The NP-epitopes based competitive ELISA kits (ID screen®PPR competition, ID vet, Grabels, FRANCE) was used for screening of anti-PPRV nucleoprotein antibodies in serum according to the manufacturer's protocol. The absorbance was read at 450nm with an ELISA reader (BioTek ELX800). Samples were presented as S/N%, S/N ≤ 50% - positive, >50 - ≥60%-doubtful and >60% were considered negative.

Table 1: *Epidemiological data of outbreaks in Hail, Saudi Arabia*

Outbreak (Date)	Species	Vaccination	No. affected (%)	No. dead (%)	Case fatality rate (%)	Total
1st Outbreak (February 2016)	Goats	X	130 (65)	57 (29)	43.8	200
	Sheep	X	150 (50)	37 (12)	24.7	300
	Camels	X	0	0	0	0
	Total		280	94	33.6	500
2nd Outbreak (April 2016)	Goats	X	83 (63.8)	62 (47.7)	74.69	130
	Sheep	√	0	0	0	70
	Camels	X	0	0	0	9
	Total		83	62	24.53	209
3rd Outbreak (April 2016)	Goats	X	35 (70)	7 (14)	20	50
	Sheep	X	150 (50)	47 (16)	31.3	300
	Camels	X	0	0	0	4
	Total		185	54	29.19	354
4th Outbreak (May 2016)	Goats	X	0	0	0	0
	Sheep	X	100 (40)	61 (24.4)	61	250
	Camels	X	0	0	0	0
	Total		100	61	61	250

Table 2: *Morbidity& mortality rates according to age*

	Age group	No. affected (%)	No. dead (%)	Case fatality rate (%)	Total
1st Outbreak	Young	150 (73.5)	54 (26.5)	36	204
	Adult	130 (76.5)	40 (23.5)	30.8	170
	Total	280 (74.9)	94 (25.1)	33.8	374
2nd Outbreak	Young	44 (52.4)	40 (47.6)	90.9	84
	Adult	39 (63.9)	22 (36.1)	56.4	61
	Total	83 (57.2)	62 (42.8)	74.7	145
3rd Outbreak	Young	75 (80.6)	18 (19.4)	24	93
	Adult	110 (75.3)	36 (24.7)	32.7	146
	Total	185 (77.4)	54 (22.6)	29.2	239
4th Outbreak	Young	100 (62.1)	61 (37.9)	61	161
	Adult	0	0	0	0
	Total	100 (62.1)	61 (37.9)	61	161

Table 3: *Morbidity& mortality rates according to sex*

		Male		Female		
		No. affected (%)	No. dead (%)	No. affected (%)	No. dead (%)	Total
1st Outbreak	Goats	37 (19.8)	13 (6.9)	93 (49.7)	44 (23.5)	187
	Sheep	23 (12.3)	7 (3.7)	127 (67.9)	30 (16)	187
	Camels	0	0	0	0	0
	Total	60 (16)	20 (5.3)	220 (58.8)	74 (19.9)	374
2nd Outbreak	Goats	35 (24.1)	24 (16.6)	48 (33.1)	38 (26.2)	145
	Sheep	0	0	0	0	0
	Camels	0	0	0	0	0
	Total	35 (24.1)	24 (16.6)	48 (33.1)	38 (26.2)	145
3rd Outbreak	Goats	3 (7.1)	0	32 (76.2)	7 (16.7)	42
	Sheep	23 (11.7)	4 (2)	127 (64.5)	43 (21.8)	197
	Camels	0	0	0	0	0
	Total	26 (10.9)	4 (1.7)	159 (66.5)	50 (20.9)	239
4th Outbreak	Goats	0	0	0	0	0
	Sheep	100 (62.1)	61 (37.9)	0	0	161
	Camels	0	0	0	0	0
	Total	100 (62.1)	61 (37.9)	0	0	161

3ABC-FMD ELISA

Enzyme immunoassay kits (IDEXX FMD 3ABC Ab test. IDEXX Laboratories, Inc.Westbrook, Maine 04092.USA) was used for detection of nonstructural polyprotein (NSP) 3ABC of FMD antigen, it was performed in accordance to the manufacturers' instructions. Samples with percentage values >30% -positive, >20% -negative and samples between 20 and 30% were considered suspicious.

Results

Epidemiological investigation

During the four outbreaks 271 (20.6%) died out of 648 (49.3%) of affected animals, with a case fatality reached 41.8%, no record of vaccination, the overall morbidity in goats (33.3%) was higher as compared to sheep (12.3%) (Figure 1 and Table 1). The disease affected all age groups (Table 2), morbidity and mortality rates were high among female animals (Table 3).

Clinical signs

Affected animals exhibited fever (up to 41°C), loss of appetite, stomatitis, hyper salivation, respiratory distress, mucopurulent to bloody nasal/ocular discharges, watery to bloody diarrheaand lameness (Figure 2).

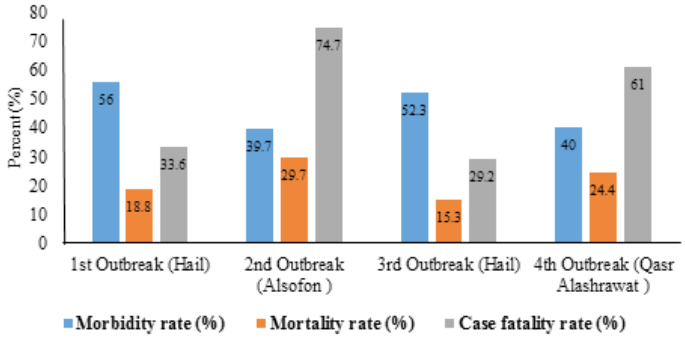

Figure 1: *Morbidity, Mortality and case fatality rates during PPR-FMD outbreaks*

Necropsy findings

Dissection of animals revealed erosions on the soft and hard palates, hemorrhages in lung (evidence of pneumonia), iver, abomasum, small and large intestine (Figure 3).

Sandwich ELISA

The presence of PPRV-antigen was detected in 38 swabs (82.6%) from sheep (n=20) and goats (n=18). Camel swabs were non-reactive.

c-ELISA

Screened sheep and goat sera were positive, camels were seronegative for anti-PPRV nucleoprotein antibodies.

FMD ELISA

Six ovine sera (30%) were positive for anti-NP antibodies while goats were negative.

Figure 2: *Infected animals showed* **A-B.** *Salivation* **C-D.** *dried mucopurulent discharges§* **E-F.** *erosions on lips, gum, soft and hard palates, tongue and cheeks* **G.** *white nodule on gum* **H.** *ocular discharges* **I**. *reddened eye* **J-K.** *watery to bloody diarrhea.*

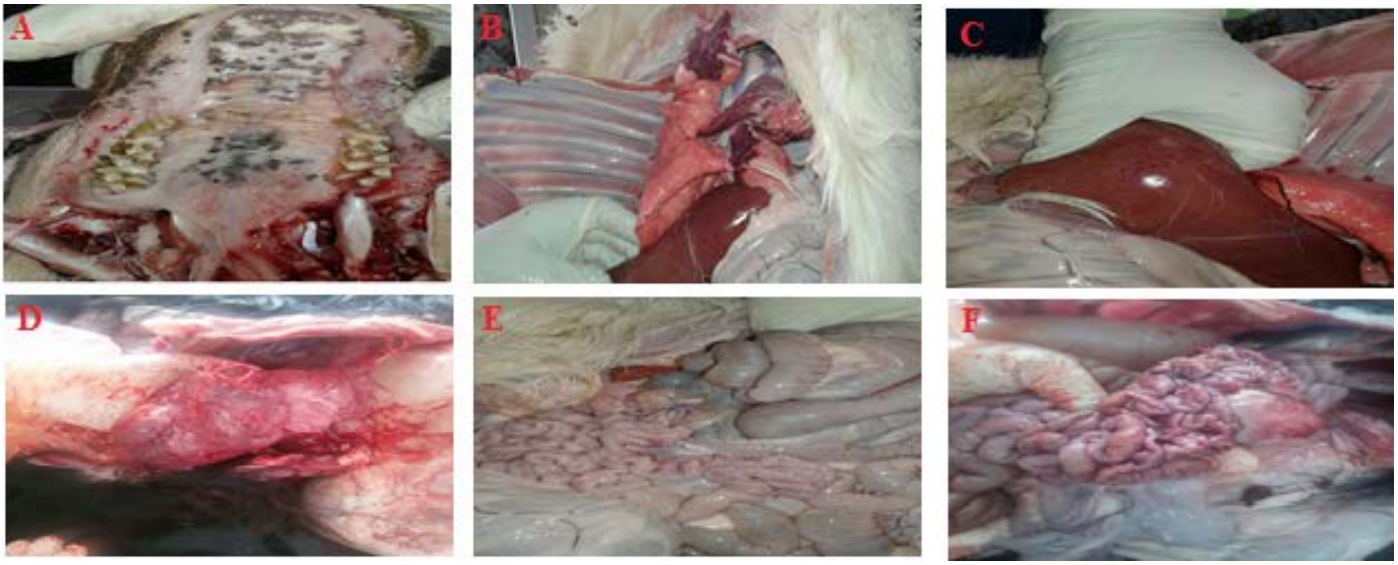

Figure 3: *Postmortem examination of infected animals revealed* **A.** *False membranes; erosions on the soft and hard palates. Hemorrhage in* **B-C.** *lung (evidence of pneumonia) and liver* **D.** *Abomasum* **E-F.** *small & large intestine*

Discussion

PPRV is one of the most prevalent infectious diseases among sheep and goats and is considered an emerging economically important disease in Saudi Arabia (Abu-Elzein et al., 1990; Al-Dubaib., 2009; Banyard et al., 2010; Mahmoud et al., 2016, 2017). In the present study, outbreaks occurred in four mixed farms were investigated, PPRV-NP, anti-PPRV-NP were detected from sheep and goats and FMD-NSP were positive from sheep sera. During the outbreaks 271 (20.6%) died out of 648 (49.3%), the overall morbidity in goats (33.3%) was higher as compared to sheep (12.3%), a case fatality rate was high in goats (74.69%), other authors found a mortality of 23 – 100% (Abu Elzein et al., 1990; Taylor et al., 1990; Chowdhury et al., 2014). Mahmoud and Galbat (2017) reported high susceptibility of sheep flocks to the infection with FMD and PPR viruses, with positivity rates of 76% for FMD and 64% for PPR antigen, the susceptibility of sheep and goats can vary with the breed of animal and strain of virus (Kitching and Hughes, 2002). Previous studies indicated that more severe disease results from mixed infection of bacteria and viruses (Osman et al., 2009). We did not take any attempt to isolate bacteria from these cases.

Young animals (6–12 months) were more susceptible than the aged, which are inconsistent with the findings of Taylor et al. (1990). This may be due to maternally derived PPR antibody that persists up to 4 months (Libeau et al., 1992). It is likely that antibody derived from sub-clinical infection in aged goats protected themselves as well as their young progenies. This observation was in accordance with reports of Taylor et al. (1979).

Foot and mouth disease (FMD) is considered one of the enzootic diseases in Saudi Arabia (Al-Mezaini et al., 1985; Aidros, 2002; Yousef et al., 2012). Sheep infections are frequently mild or in apparent (Geering, 1967; Donaldson and Sellers, 2000), often been implicated as disseminators of the virus (Krystynak, 1987; Barnett and Cox, 1999). Saudi Arabia imports annually millions of live ruminants for slaughter. The majority of these animals are imported from countries where FMD is enzootic, importing either carrier animals which might act as potential source of infection or subclinical infected animals which might actively excrete FMD virus (Hafez et al. 1994).

The present investigation detected mixed PPR-FMD infections among small ruminants in Hail. Saudi Arabia, large-scale sero-prevalence and molecular identification of the circulating strains will help in implementing proper control measures.

Authors' Contribution

Mahmoud, A.Z., M. Abdellatif investigate the clinical picture of the outbreaks, test samples and wrote the manuscript. M. Abdalla supervised the study and revised the manuscript, all read and approved it for submission.

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