Is orf infection a risk to expanding goat production in developing countries? A study from Lao PDR


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ABSTRACT

Following increases in demand for goats in Laos and in adjacent Vietnam in Southeast Asia, reports of several outbreaks of suspected foot-and-mouth disease (FMD) were investigated in September–October 2016 in four Lao rural villages. The investigation involved clinical and pathological examination of infected animals, plus interviews of goat smallholder farmers (n = 33). Serum (n = 32) and oral and facial lesion tissue (n = 8) samples were collected, with sera submitted for serological tests for FMD and tissues examined by histopathology. The sera were negative for FMD antibodies and histopathology confirmed the lesions were due to orf virus infection. Of the farmers interviewed, 25 indicated that several of their goats displayed clinical signs of oral or facial skin disease, with lesions extending from the lips and surrounding tissue extending occasionally to the ears, although they were unable to provide a reliable response on when the disease first occurred. Of the average infected herd size of 9 goats, 3 displayed clinical signs consistent with orf and one animal (less than six months of age) died from orf infection. The investigation concluded that these outbreaks were due to orf infection and it was highly unlikely that previous or concurrent exposure to FMD virus was a contributing risk factor. Extension programs are required to assist smallholder goat farmers improve their knowledge and practice of goat health and production. With a rapidly increasing population of goats in smallholder and more recently commercial goat production systems in Laos, improved biosecurity to manage the risks of infectious diseases including orf, is advised.

1. Introduction

Orf is an epitheliotropic virus and member of the genus parapox, a zoonotic disease of small ruminants with infection causing contagious ecthyma (also known as scabby mouth or sore mouth) (Spyrou and Valiakos, 2015). Infection of skin and oral mucosa causes an erythema that quickly progresses to pustules and then leading to hypertrophic and hyperplastic lesions with scab and crust formation (Matthews, 2013). The lesions are most commonly found on the lips and lip commissures, but may also be found on the muzzle, nostrils, ears, eyelids, feet, scrotum, vulva and udder (Leite-Browning, 2008). The disease is often of economic importance in sheep and goats, particularly as the early lesions may suggest vesicular diseases that can compromise livestock trade (Nandi et al., 2011; Spyrou and Valiakos, 2015). Outbreaks of orf generally have low mortality although morbidity rates can be high. They can lead to weight loss resulting from reduced feed consumption due to painful lesions around the mouth, teats and feet (Matthews, 2013), particularly in young animals (Abdullah et al., 2015). Occasionally, high mortality rates from orf infection have been reported in young kids (Haig and McInnes, 2002), probably due to inability to suckle from oral lesions and rejection by does due to severe test and udder lesions (Matthews, 2013). Mortality rates may increase in kids when secondary bacterial or fungal infections (Haig and McInnes, 2002). Without secondary complications, orf is usually a self-limiting disease, with lesions typically recovering within six weeks of onset, with recovered animals remaining immune from re-infection for a few years (Matthews, 2013).

Clinical signs and lesions of orf can often be difficult to differentiate from those of other diseases that cause lesions of the mouth, nose and face, including capripox virus, foot-and-mouth disease (FMD), parasitic mange, blue-tongue and staphylococcal infections and other dermatologic disorders (Matthews, 2013; Spyrou and Valiakos, 2015). Although lesions from orf and FMD viral infections are potentially distinguishable based on clinical signs as orf induces visible epithelio-proliferative
lesions whereas FMD does not (Nandi et al., 2011), using this feature to differentiate between the two diseases is time dependent. As orf infection may present with lesions that initially resemble FMD, the two diseases may be difficult to distinguish visually and it may be increasingly important to ensure that both diseases are not occurring at the same time in outbreaks of facial and oral lesions. Consequently, a laboratory diagnosis is advised for determination of the disease occurrence and to ensure that only one infectious agent is involved in outbreaks of oral and facial disease in small ruminants (Nandi et al., 2011).

The necessity to accurately diagnose orf infection has become increasingly important issue in the Lao People’s Democratic Republic (Lao PDR or Laos) where FMD is prevalent (Khounsy et al., 2009; Nampanya et al., 2012), although appears to have been controlled in some areas recently. Importantly, both diseases are controlled by entirely different interventions, including different vaccination strategies. Further, orf is a potential zoonotic risk to people handling infected animals (Matthews, 2013) or administering orf vaccine.

The main goat breed found in Laos is the indigenous Kambing-Katjang, although there have been numerous recent importations of goats of various breeds from neighbouring countries, particularly Thailand. The local breed is a meat goat native to the Indo–China peninsula and considered well adapted for the tropical conditions and feed quality (Gansberghe, 2005). Although goats are a browsing species, in Laos they are often managed in multi-species grazing systems, with goats grazing with cattle to reduce competition from shrub weeds (Glimp, 1995). Typically, Lao smallholder goat herds consist of 3–10 animals, although there is recent widespread expansion of these herds with as many as 200 animals in commercial herds (Phengvichith and Preston, 2011). Approximately 215,600 goats were recorded in Laos in the 2011 agricultural census (Steering Committee for Lao Census of Agriculture, 2012). However, this is likely to be underestimated the numbers of goats in Laos that is increasing rapidly due to expanding demand for goat meat, particularly from Vietnam, with possibly 2000–3000 goats per month exported (Phengsavanh and Hoang, pers. comm.).

In the past two years, there have been a series of reports of a skin disease of the mouth and face of goats, suspected as FMD, in many Lao rural communities. No previous systematic studies have investigated these reports, although images of lesions sent to the investigators of this study were considered suggestive of orf. The reports prompted an investigation of several outbreaks in four Lao rural villages to determine the aetiology of the disease, clarify the status of exposure of these animals to FMD, and investigate the knowledge of smallholder farmers of these diseases and goat husbandry. An expected outcome was to provide recommendations and policy advice for managing orf in the smallholder and emerging commercial goat production systems in Laos to enhance the capability to supply increasing regional export demand.

2. Materials and methods

2.1. Study site and farmer selection

This study was conducted in September–October 2016, in four villages in the vicinity of the Faculty of Agriculture (Nabong campus), National University of Laos, located in the Xaythany district, approximately 40–60 km from Vientiane Capital Laos. A series of reports of outbreaks of facial or oral lesions in goats had been reported in 2016. In each village, 5–10 farmers (n = 33) identified as keeping a goat herd were randomly selected for the interview based on their willingness to participate in the interview and consultation with village veterinary workers and village headmen.

2.2. Survey questionnaire and farmer interview

A farmer knowledge, attitude and practices (KAP) questionnaire was developed by a research team from the University of Sydney and the Lao Department of Livestock and Fisheries. A semi-structured (categorical and quantitative) questionnaire, consisting of open, closed and semi-closed questions was developed. The questionnaire was written in English and translated into Lao by the research team. The interviews were conducted in the Lao language, taking approximately 30–60 min per farmer. This survey collected data on financial status and animal health. It also assessed the ability of farmers to distinguish lesions of orf from FMD clinical signs, using two standardised images. The intent was to estimate both the knowledge of farmers on orf and FMD infections and to estimate the prevalence of orf lesions in goats in the surveyed herds.

The first part of the survey covered general and specific information including: the farmers’ gender and age; their total annual income; and the income derived from goat production, agricultural land and farm products (e.g. sale of vegetables and rice), small non-ruminant livestock (poultry and pigs), large ruminants (buffalo and cattle) and “other” sources of income. Additional questions aimed to determine the number of goats currently owned, number of goats born and dying in the past year, and suspected reasons for sickness and deaths of goats.

The second part of the survey included a series of questions on orf and FMD to establish farmers’ current knowledge and practices, and to identify knowledge gaps of both diseases. All questions had the option of the answers “Yes”, “No” and “I don’t know” unless stated otherwise. Firstly, farmers were asked if they knew what the signs of FMD and what the signs of orf were and if these signs had occurred in their herd. The interviewer then presented two images, one of an animal with orf lesions and another one of animal with FMD lesions. The farmer was asked to identify each as either “orf”, “FMD” or “I don’t know”. Following these questions, each farmer was asked if he or she separated their ill stock from healthy animals when they saw clinical signs of disease. Finally the survey concluded by asking if the farmer or anyone in their family have been infected by orf in the past.

2.3. Sample collection and analysis

In each selected village, 5–10 serum samples were collected (n = 32), particularly from those animals with suspected orf or FMD cases that were present at the time of the investigation. The serological examination aimed to determine whether the FMD virus was or had been active in that particular goat population. Samples of lesions including the margins of affected tissue were taken from several cases (n = 8) and preserved in 10% buffered formalin for histological examination to determine the cause of the disorders.

Serum samples were submitted to the National Animal Health Centre in Vientiane capital Laos for serological examination for FMD, using the 3ABC non-structural protein (NSP) enzymed-linked immunosorbent assay (ELISA), performed using a commercial ELISA test kit (Thermo PRIOCHECK®; Thermo Fisher Scientific, US) according to manufacturer instructions (Bronsvoort et al., 2006). As electronic microscopy and culture for orf virus are not available in Laos, two of the 8 affected tissue samples were conveyed to and examined at the University of Sydney. The samples were prepared for microscopic examination by routine processing and embedding in paraffin blocks that were cut with a microtome enabling 6 μm thin sections to be floated onto microscope slides, then stained with haematoxylin and eosin prior to examination by an experienced specialist pathologist (PW).

2.4. Data management and analysis

The survey data were transcribed into spreadsheets in Microsoft Excel with basic descriptive analysis presented. Comparisons between suspected orf affected farmer groups and unaffected farmer groups were also performed using a chi–square test in Microsoft Excel.
3. Results

3.1. Descriptive analysis of goat farmer interviews

The number of interviewed farmers, their goat herd size and financial status, were tabulated (Table 1). Of the 33 farmers interviewed, the average age of the farmers was 49 (± 5) years, ranging from 19 to 73 years old, including 17 male and 16 female farmers. The average number of goats per household was 9 (± 5, range: 2–21) and the annual income from sale of goats was US$ 394 (± 385) per household, representing 22% of the total annual cash income. Over the previous year, 16 farmers sold/exchanged goats, with an average of four goats (range: 1–20 goats) per annum and an average price of US$ 105 per goat (range: US$ 77–172).

Table 1
Number of interviewed farmers and their goat herd health status by farmer categories.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Orf affected group</th>
<th>Orf unaffected group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer interviewed (female)</td>
<td>25(12)</td>
<td>8 (4)</td>
<td>33(16)</td>
</tr>
<tr>
<td>- Mean age (yrs)</td>
<td>49 (± 13)</td>
<td>49 (± 12)</td>
<td>49 (± 13)</td>
</tr>
<tr>
<td>Mean goat herd size (heads)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean total herd size</td>
<td>9(± 5)</td>
<td>10(± 5)</td>
<td>9(± 5)</td>
</tr>
<tr>
<td>- Mean does/nanny</td>
<td>6(± 3)</td>
<td>7 (± 4)</td>
<td>6(± 3)</td>
</tr>
<tr>
<td>- Mean kids</td>
<td>2(± 2)</td>
<td>2(± 1)</td>
<td>2(± 2)</td>
</tr>
<tr>
<td>Farmer financial status(USD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean annual incomes</td>
<td>1788(± 1551)</td>
<td>1785(± 1641)</td>
<td>1787(± 1574)</td>
</tr>
<tr>
<td>- Mean income from goat</td>
<td>366(± 321)</td>
<td>478(± 523)</td>
<td>394(± 385)</td>
</tr>
<tr>
<td>- Mean income from agriculture</td>
<td>199(± 303)</td>
<td>185(± 405)</td>
<td>196(± 331)</td>
</tr>
<tr>
<td>- Mean income from pig and poultry</td>
<td>116(± 209)</td>
<td>73(± 75)</td>
<td>106(± 186)</td>
</tr>
<tr>
<td>- Mean income from cattle and buffalo</td>
<td>364(± 386)</td>
<td>154(± 408)</td>
<td>314(± 402)</td>
</tr>
<tr>
<td>- Mean income from other activities</td>
<td>742(± 1203)</td>
<td>895(± 1154)</td>
<td>779(± 1193)</td>
</tr>
<tr>
<td>- % income from goat and total annual income</td>
<td>21</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>Herd annual mortalities (heads)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean Annual mortalities</td>
<td>2(± 3)</td>
<td>2(± 2)</td>
<td>2(± 3)</td>
</tr>
<tr>
<td>- Mean does/nanny deaths</td>
<td>1(± 2)</td>
<td>1(± 1)</td>
<td>1(± 2)</td>
</tr>
<tr>
<td>- Mean kids death</td>
<td>1(± 2)</td>
<td>1(± 1)</td>
<td>1(± 1)</td>
</tr>
<tr>
<td>Recent orf outbreaks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean goat showing orf clinical signs</td>
<td>3(± 3)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>- Mortality rate (%)</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean goat death caused by suspected orf</td>
<td>1(± 1)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>- Mortality rate (%)</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Number of days recovered from orf</td>
<td>17(± 14)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

mean ± standard deviation.

3.2. Orf infection and smallholder goat health and production

Of the farmers interviewed, 25 farmers said that some of their goats showed clinical signs suggestive of orf infection, with skin lesions at the area of mouth, lips and ears (Table 1 and Fig. 1). When asked when the disease first occurred, none of the farmers could give a reliable answer. Of the average infected herd size of 9 goats, 3 displayed clinical signs consistent with orf infection and one animal (less than six months of age) had died from orf.

The survey also identified an annual loss per household of two animals (± 3, range: 1–8), with 10 farmers reporting as having no deaths. Farmers attributed the suspected reasons for the deaths as orf, dog bite, strangulation, black-leg, pneumonia and an abdominal disorder (described as stomach ache, bloat or watery faeces and interpreted as probably indicative of internal parasitic infection).

The interviewed farmers reported the most important diseases in their herds as orf and/or FMD, sore mouth, sore eyes, abdominal disorder (stomach ache, bloat, watery faeces) and lameness. Both orf and FMD were reported as important diseases by at least one farmer from each village, although many answers listed including “sore eyes”, “sore mouth” and “lameness”.

3.3. Smallholder goat farmer's knowledge, attitude and practices toward orf and FMD

The farmer knowledge, attitude and practices (KAP) toward orf and FMD were tabulated (Table 2). Of the 25 affected farmers, 56% claimed they knew the clinical signs of orf, 44% were able to identify the image of the orf lesions correctly (P = 0.003 and 0.34). Further, 72% of the affected farmers claimed they knew the clinical signs of FMD, with 64% able to identify the image of the FMD lesion correctly (P = 0.8 and 0.5). Only 7 (21%) of the interviewed farmers stated that they separated ill
animals showing signs of orf infection from their healthy animals ($P = 0.2$). Most of the affected farmers claimed that they would use orf vaccine (not currently available in Laos) and FMD vaccines (currently only available for cattle and buffalo) if they were made available to them ($P < 0.001$ and $< 0.001$).

In addition, the investigation showed 23 of 25 farmers with infected goats stated that they had attempted some form of treatment for the lesions in their goats, including direct application of local traditional medicines. This included topical application of the astringents lemon juice and salt, or the application of boiled bark from local native trees (Ptesocarpus pedatus, Markhamia stipulata, Sesbania grandiflora, and Ziziphus jujuba). Several goats had received treatment with topical or systemic antibiotic preparations, following consultation by the farmers with a village veterinary worker or veterinarian from the livestock section of the nearby Faculty of Agriculture. This investigation identified that less than half (14 out of 33) of the farmers used de-worming.

Further, none of these farmers developed orf lesions although anecdotal reports from other provinces in Laos suggest this has occurred.

### 3.4. Serological and histological examination

Serological examination for FMD NSP identified an absence of antibodies to FMD in the samples tested, indicating it was highly unlikely that these goats had previous exposure to FMD virus.

The histological examination identified locally extensive severe proliferative dermatitis, with characteristic ballooning of the cytoplasm of hyperplastic epithelial cells in the basal dermis. This accompanied severe ulcerative dermatitis with keratinisation and widespread necrosis of keratinocytes infiltrated by mixed mainly polymorphonuclear leucocytes. These findings are considered characteristic of infection by orf virus (Fig. 2).

### 4. Discussion

This investigation confirmed that orf virus infection is present in goat herds in Laos, with anecdotal reports suggesting the disease is common in some provinces. The investigation is most likely the first report describing the importance of differentiating oral and facial disease due to orf from FMD in goats in Laos. Orf is likely to be an increasingly important health issue in the smallholder and emerging commercial goat production systems in Laos and neighbouring countries, particularly as it is a zoonosis, vaccination is currently unavailable, and the disease may compromise live export trading. The presence of scabby mouth lesions in sheep exported live from Australia to Saudi Arabia, created one of the most significant livestock welfare crises in Australia with in excess of 50,000 sheep stranded on a boat in the Middle East due to confusion over the diagnosis of orf from FMD (Fletcher and Crawford, 2013).

Suspicions that the facial lesions shown to be caused by orf may have been predisposed to or precipitated by previous or concurrent infection with FMD, were not confirmed. It is noted that in the Lao language, the diseases “orf” and “FMD” have a very similar name and description. Given that FMD outbreaks have occurred regularly in large ruminants in many parts of Laos in the past 10 years, and that many Lao farmers keep their cattle and goats in close proximity (Khoumwy et al., 2009; Nampaya et al., 2012), it was important that laboratory examinations and diagnostic criteria in this investigation was used to provide certainty in differentiating the facial and oral lesions as due to orf virus and not FMD. However, the findings on the FMD status of goats in Laos are preliminary and further serosurveillance and clinical monitoring for FMD in Laos goats is highly recommended.

Orf virus was certainly identified as an issue of concern to the smallholder goat farmers (Spyrou and Valiakos, 2015). With no literature or further information available on the use of traditional medicine options for orf clinical sign treatment, some local authorities appear tempted to promote the use of antibiotics on the basis that this may prevent secondary bacterial infection (Nandi et al., 2011). This behaviour by veterinary workers has also been noted in surveys on the cost of FMD in large ruminants in Laos, with antibiotics used for ‘prevention of secondary bacterial infection’ resulting in significant escalation of the cost of the disease on poor households (Nampaya et al., 2015). Of concern is that inappropriate use of antibiotics for FMD in large ruminants and now orf in goats, may predispose to increased risk of both antibiotic residues in food and development of antimicrobial resistance. More suitable treatment options may include: application of a 3% iodine solution to the lesions (Leite-Browning, 2008) or a mixture of iodine with petroleum jelly (e.g. Vaseline) (Nandi et al., 2011), application of topical ointments containing KMnO₄ and boric acid (Spyrou and Valiakos, 2015), 1% (w/v) cidofovir cream applied for four consecutive days (Greenick et al., 2001; Nandi et al., 2011), oils of sesame or castor plants, the juice of Calotropis procera (known as Sodom apple or rubber tree) or Euphorbia spp. (de Clercq, 2002; van Lenger et al., 2006; Nandi et al., 2011). With very limited study and therapeutic validation of many of these options for orf in goats, future clinical trials are necessary before more definitive advice can be given on treatment of orf lesions.

Prevention of viral entry into damaged epithelium is an important consideration in controlling the impact of orf infections. Transmission of the virus involves entry through disruption of the integrity of the epidermis, with viral replication in basal epithelial cells (Spyrou and...
Valiakos, 2015), so that animals grazed on rough, abrasive vegetation will be prone to orf infections (Matthews, 2013). Avoiding provision of such feeds, separation of ill animals from healthy animals (Nandi et al., 2011) and the use of levamisole as an immuno-stimulant when animals are at risk of infection with the orf virus, have been previously advocated (Wilson et al., 2002). Prevention of excessive moisture of interdigital skin may reduce the risk of entry of orf virus into the epithelium of the feet. Orf lesions of the feet were not observed in this investigation, probably because the goats were browsing in areas where excessive moisture was minimal. It was noted that as few females goats in this investigation were lactating and teat lesions were also not observed. As the usual parturition period for goats in Laos is currently March–May, there were few kids at foot during this investigation. Vaccination is currently the most efficacious option for limiting the impact of orf and has been used in many countries (although orf vaccines are not currently available in Laos). Orf vaccines use viable virus to induce infection at a more suitable time in the production cycle and in a less injurious location (e.g. skin of the medial axillary region). Although this strategy has its limitations, providing immunity of only intermediate duration, and has occasionally been recorded as the source of an outbreak of orf in animals (Gilray et al., 1998; Haig and McInnes, 2002), vaccination has an important role in managing the disease. There also appears to be a significant enough difference between sheep and goat strains of orf virus, that failure of the sheep orf vaccine strain to protect goats has been observed (Nandi et al., 2011) and goat specific vaccines are considered more effective when used in goats than currently available commercial orf vaccines for sheep (Muser et al., 2008; Spyrou and Valiakos, 2015). There appears to be a need for development of an efficacious goat specific vaccine for management of orf in the region.

This investigation identified that smallholder goat farmers in Laos had limited knowledge of both orf and FMD, and is consistent with previous studies of Laotian smallholder farmers (Nampanya et al., 2010). Education and animal health intervention program for smallholder farmers to improve their disease awareness and husbandry practices have previously been advocated to manage the biosecurity risks of FMD in large ruminants in Laos (Nampanya et al., 2015). Extending these programs to goat farmers with advice on management of orf is also advisable, particularly given that only seven of the 33 farmers stating that they separated their sick animals from their healthy ones when signs typical of orf or FMD are recognised.

In addition to orf, there are many other potential constraints in the raising and export of goats in and from Laos and neighbouring countries. These include: high mortality rates of kids; increasing risk of metabolic disorders; internal and external parasitism; and the risk of transboundary diseases including FMD, brucellosis, potentially pestes des petit ruminants; and disease such as Caseous Lymphadenitis and paratuberculosis (Johnes' disease) and Q fever that are or are likely to be endemic in goats in Laos and neighbouring countries. Further, lack of feedable and seasonal deficiencies in both quantity and quality of nutrition is likely to be increasingly important (Gray et al., 2012; Stir et al., 2002) as trading of goats increases and becomes more commercial. Efforts to improve productivity through intensification have commenced, despite risk of the compounding problems with intensification, especially where grazing occurs. Management difficulties are also inherent in free raising systems, particularly where biosecurity is lacking and no vaccination or de-worming programs are in place (Gray et al., 2012). Of concern was that two farmers admitted that they administered antibiotics for the purpose of deworming, despite the antibiotics used having no specific anthelmintic properties.

Orf in Laos is a potential risk to the expanding goat meat trade in the region. Policy considerations on control of this zoonotic disease in Laos and neighbouring countries appear warranted. This investigation indicates there is a particular need for improved education of smallholder and commercial goat farmers on goat health and production practices in Laos. This requires support from systematic caprine research studies to provide practical evidence-based approaches to assist goat farmers improve their knowledge, attitude and health, biosecurity and husbandry practices, enabling increased goat productivity to improve farmer livelihoods and contribute to addressing regional food insecurity.

Acknowledgements

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.smallrumres.2017.08.003.

References


