

SEROLOGICAL SURVEY OF FOOT-AND-MOUTH DISEASE IN SHEEP IN THE
CENTRAL VALLEY OF COCHABAMBA, BOLIVIA

Ministry of Agricultural and Peasant Affairs of Bolivia*

Food and Agriculture Organization of the United Nations**

Pan American Health Organization***

SUMMARY

A serological survey in the south of the central valley of Cochabamba, Bolivia, showed a high percentage of subclinical infection of foot-and-mouth disease in a sheep population kept in close contact with cattle that had suffered from a severe epidemic of the disease. VIA tests showed that a prevalence rate of $44 \pm 6\%$ of foot-and-mouth disease existed in the cattle population ($P < 0.05$). About 40% of the owners who stated that their sheep had not had the disease were shown to have sheep with VIA antibodies.

INTRODUCTION

Several investigators have indicated that sheep can be an important host for foot-and-mouth disease (FMD) virus under natural conditions (1, 4, 6, 7, 8, 10) but the exact role that sheep play in the epidemiology of the disease is still an open question.

Sheep can be easily infected by close contact with infected animals (1, 9); aerosol transmission may also play an important role (11).

McVicar and Suttmöller, studying the spread of FMD in groups of sheep, found that fever and lesions are useful indicators of infection, although they are too variable to be used as the only criterion (9). The few reports on outbreaks of FMD in sheep under field conditions agreed that the lesions are often small and difficult to observe (5). They also showed that a high percentage of infected sheep developed circulating neutralizing antibodies as well as virus-infection-associated-antigen (VIA) antibodies (9).

In the central valley of Cochabamba, Bolivia, the disease is endemic, and cattle and sheep are kept together mainly on small farms. Types O, A and C virus have been isolated in the 1970's. From 1974 to September 1975, an epidemic of subtype A₂₄ among cattle in the southern part of the valley, although no FMD was reported in sheep. The sheep population is not vaccinated, although until the time of the study cattle were systematically vaccinated against FMD.

Under these circumstances, the Directorate of the Animal Health Program of the Ministry of Agricultural and Peasant Affairs (MACA) (Project 73/012 of the United Nations Development Program-UNDP) which was carried out

* Freddy Fernández T.; Angel Quitón P. Programa de Sanidad Animal, Casilla 3224, Cochabamba, Bolivia.

** Godofredo Mauricio Bulman. Programa de Sanidad Animal, Casilla 3224, Cochabamba, Bolivia.

*** Maria Elma V. Ferreira; Magnus Stael Söndahl; A. Alonso Fernández. Pan American Foot-and-Mouth Disease Center, Caixa Postal 589-ZC-00, Rio de Janeiro, RJ, Brasil.

by the Food and Agricultural Organization of the United Nations (FAO) in Bolivia, decided to study the relationship of the outbreak and the sheep as potential hosts. This retrospective survey, carried out with the assistance of the Pan American Foot-and-Mouth Disease Center (PAFMDC), used interviewing and serological samples to determine infection rates of neutralizing antibodies. This report presents the results of that survey.

MATERIALS AND METHODS

The central Cochabamba valley has approximately 8,000 hectares with 1,900 livestock owners and 12,000 cattle. Moreover, 1,400 of the owners also keep a total of 10,200 sheep. Approximately 56% of the owners have farms of less than 1 hectare and 40% have 1 to 5 hectares. The predominant breed of cattle is Frisian-Holstein and that of sheep is merino. A comparison of the area and the cattle and sheep population showed the existence of 1.8 animals per hectare.

An interview survey* was carried out to estimate the prevalence of FMD during 1974-1975, taking as its universe the 1,400 owners who raise cattle and sheep in close contact. Survey samples of sheep were collected. The survey was made on the basis of samples taken by means of a 2-step selection procedure. In the first step 81 owners were selected with probability proportional to the size of the herd. The 81 owners equally 1/17 of the surveyed farmers. In the second step, a random selection of 3 sheep per herd was made, giving a total of 240 sheep for bleeding, a sample fraction of approximately 1/43. A prevalence of 20% and precision of 5% were assumed.

The sera were examined at the PAFMDC where the statistical analysis was also performed. The agar gel double diffusion test was

*The sample design was developed by Dr. Raúl Serrano J., MACA, Bolivia.

used for the detection of VIA antibodies (8) and circulating neutralizing antibodies were tested by microtechniques (2).

RESULTS

Table 1 shows that 47% of the 81 surveyed declared that their cattle had FMD in 1974 and 54% in 1975. For each year, only 5% had observed the disease in their sheep. Serological testing of 192 sheep showed that 84 were VIA-positive, indicating that with $P < 0.05$ the prevalence of FMD virus infection in the sheep population was $44\% \pm 6\%$.

TABLE 1. Herds of cattle and sheep with FMD according to interviews. Cochabamba, Bolivia, 1974-1975.

Year	Herds with	
	Affected cattle	Affected sheep
1974	39/81(47%)	4/81(5%)
1975	44/81(54%)	4/81(5%)

Table 2 shows that in November 1975, 45 (56%) of the 81 surveyed herds had one or more VIA-positive sheep in contrast to the 5% observed by farmers in the same year. Relating this result to the occurrence of FMD in cattle on the same farms it can be seen that 58% and

TABLE 2. Herds according to VIA in sheep in November 1975 and occurrence of FMD in cattle in 1974 and 1975. Cochabamba, Bolivia.

Year	Herds according to VIA in sheep in 1975	
	+	-
1974	26/45(58%)	13/36(36%)
1975	30/45(67%)	14/36(39%)

67% of the owners declared to have had disease in 1974 and 1975, respectively.

Table 3 shows the relationship of VIA antibodies and circulating antibodies in the 192 sheep sera that could be analyzed of the 240 sent from Cochabamba. Of 109 sera with neutralizing antibodies, 36% were positive for virus O, 48% for virus C and 55% for virus A. Of the 192, 33% had neutralizing antibodies for two or all three types of virus. These results coincide with the chronology of diagnosis of the types of virus. It is interesting to note that all sheep with VIA antibodies also had neutralizing antibodies, as did 32% of the VIA-negative sheep.

TABLE 3. *VIA antibodies and neutralizing antibodies in sheep serum from Cochabamba, Bolivia, 1974.*

		VIA antibodies		Total sheep
		+	-	
Neutralizing antibodies	+	70	39	109
	-	0	83	83
Total		70	122	192

Table 4 shows a similar association within sheep herds. All VIA-positive flocks had one or more sheep with circulating antibodies.

TABLE 4. *VIA antibodies and neutralizing antibodies in sheep herds from Cochabamba, Bolivia, 1975.*

		VIA antibodies		Total herds
		+	-	
Neutralizing* antibodies	+	42	15	57
	-	0	23	23
Total		42	38	80

* At least 1 positive animal in the herd.

as did the 40% of VIA-negative herds. We would like to note that nearly 75% of the 57 infected flocks were detected by the VIA test.

DISCUSSION AND CONCLUSIONS

The research carried out in Cochabamba shows that a high prevalence of FMD in sheep can take place without any visible signs occurring. This phenomenon could be due to a combination of the factors, including inapparent infections, clinical signs of short duration and lack of attention by the owners. It is important to note that foot-rot or other causes of lameness are not considered important as long as the signs are not widespread or do not inhibit the animal's movements.

However, sometimes, epidemics in sheep are noticeable, especially when the disease attacks during the lambing season causing a high mortality among newborn lambs.

It is clear that the FMD epidemics in cattle during 1974 and 1975 in Cochabamba produced an appreciable inapparent infection within sheep populations on the same premises. Under these circumstances, the role played by sheep in the maintenance and transmission of virus among cattle is still not clear. However, favorable results against FMD have been obtained in some places with vaccination limited almost exclusively to cattle. This indicates that sheep are a secondary factor in the persistence of the virus.

The VIA test proved to be most useful in the detection of infection, although some of the VIA-negative sheep also had neutralizing antibodies. This could be caused by the lack of development of VIA antibodies, by a greater persistence of neutralizing antibodies, and by the effect of vaccinations. This last factor is unimportant in Cochabamba since the sheep are usually not vaccinated. The distribution of neutralizing antibodies along with the record

of virus typing would seem to favor an infectious process. Also, the titers of the neutralizing antibodies were very high, with no intermediate values, which suggests an infectious process and not the effect of vaccination.

The existence of infected animals which are VIA-negative, also observed in other studies (3, 9), indicates the need to consider

this factor when carrying out future studies of populations or individuals. With population studies this is especially true in verification of a situation in areas where FMD has not been reported for a long time and hope to be declared free of the disease, which and with individual cases in terms of trade. In both cases, the results of the VIA test are valuable but must be complemented by other tests and information.

REFERENCES

1. BURROWS, R.
The persistence of foot-and-mouth disease virus in sheep. *J. Hyg., Camb.* 66 (4): 507, 1968.
2. FERREIRA, Maria Elma V.
Prueba de microneutralización para estudios de anticuerpos de la fiebre aftosa. *Bltm Centro Panamericano Fiebre Aftosa 21-22*: 17-24, 1976.
3. ALONSO FERNANDEZ, A.; AUGÉ DE MELLO, P.; GOMES, I.; ROSENBERG, F.
El uso del antígeno asociado a la infección viral (VIA) en la detección de ganado expuesto al virus de la fiebre aftosa. *Bltm Centro Panamericano Fiebre Aftosa 17-18*: 17-22, 1975.
4. GEERING, W.A.
Foot-and-mouth disease in sheep. *Aust. Vet. J.* 43: 485-489, 1967.
5. LEANIZ RIVARA, R.; GALMARINI, C.R.; GOMEZ, Br. J.P.
Fiebre aftosa en ovinos. *Gac. vet.* 31 (226): 223-236, 1969.
6. LITTLEJOHN, Annie I.
Foot-and-mouth disease in sheep. *State Vet. J.* 25 (73): 3-12, 1970.
7. McVICAR, J.W.; SUTMÖLLER, P.
Sheep and goats as foot-and-mouth disease carriers. *U.S. Livest. Sanit. Ass. Proc.* 72: 400-406, 1968.
8. McVICAR, J.W.; SUTMÖLLER, P.
Foot-and-mouth disease: the agar gel diffusion precipitin test for antibody to virus-infection-associated (VIA) antigen as a tool for epizootologic surveys. *Am. J. Epidemiol.* 92 (4): 273-278, 1970.
9. McVICAR, J.W.; SUTMÖLLER, P.
Experimental foot-and-mouth disease in sheep and goats: an epizootiological model. *Arch. ges. Virusforsch.* 38 (1): 85-96, 1972.
10. RIVENSON, S.; SEGURA, Martina; ZAKIN, M.M.
Anticuerpos en bovinos infectados experimentalmente y vacunados contra la fiebre aftosa. *Patología Animal Serie 4*, n° 14.
Trabajo realizado en el Instituto de Fiebre Aftosa del INTA y presentado en las Terceras Jornadas de la Facultad de Ciencias Veterinarias de La Plata, efectuadas en noviembre de 1964. *Revta Invest. Agrop. ser. 4 1* (14): 171-179, 1964.
11. SELLER, R.F.; PARKER, J.
Airborne excretion of foot-and-mouth disease virus. *J. Hyg., Camb.* 67 (4): 671, 1969.