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Reproductive Failure in Goats in Norway: An Investigation in 24 Herds

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Waldeland, H. and T. Løken: Reproductive failure in goats in Norway: An investigation in 24 herds. Acta vet. scand. 1991, 32, 535–541. – Twenty-four flocks comprising 2370 breeding goats were examined. Threehundred-and-sixty-nine (15.6 %) of the goats either aborted or delivered dead kids at full term, or were barren. In 23 of the herds the rate of reproductive loss ranged from 2 % to 36 %, whereas in one herd all of 54 mated goats had live kids. A loss of $\geq$ 20 % was found in 9 herds comprising 799 goats. In 11 herds comprising 946 goats the rate of reproductive failure was $\leq$ 10 %. The incidence of reproductive failure was higher in older goats than in those in their first or second pregnancy. The causes were identified in only about 3 % of the goats that aborted. It is concluded that reproductive failure in many flocks probably is associated with non-infectious causes such as nutritional and environmental factors.

abortion; goat diseases.

Introduction

During the last few years, abortion has become an increasing problem in commercial dairy goat herds in Norway. Partly due to the geographical conditions, little and often decomposed materials have been subjected to examination. In an investigation on diseases and mortality in 27 goat herds, *Melby et al.* (1986) found an abortion rate of 8.5 %, whereas 1.2 % had a false pregnancy and 3.2 % either returned to service at a later stage or were barren. Another examination 30 herds demonstrated gestational failure in 9.8 % of the does (*Løken* 1990). In most cases the cause of abortion was not detected. In the present work serological and microbiological examinations were performed in 24 goat herds to identify the causes of reproductive loss.

Material and methods

Animals

Twenty-four herds comprising a total of 2370 goats were selected for examination. In 21 herds there had been a high rate of abortion the previous year. Sixteen herds were from the county Møre and Romsdal, 6 from Sogn and Fjordane and 2 from Hordaland.

All herds were commercial dairy herds of the Norwegian breed, with a few individuals crossed with Saanen goats. The goats were kept indoors during the winter, and in most herds they were also housed during the nights in the summer. From about 6 weeks before kidding and throughout the lactation period they were given commercial concentrates with appropriate contents of protein, vitamins and minerals, in addition to grass silage and/or hay. The ration of concentrates

was reduced or withheld for a period during the last half of pregnancy in many of the herds to terminate milk production. The nutritional status of the goats was good.

Blood sampling

All goats were bled when they were about 3 months pregnant, i.e. in December 1984, and when kidding was terminated in February or March. Individual blood samples were also collected when abortion was observed or suspected. The samples were received at this laboratory within 1–2 days. The sera were stored at –20°C until examination.

Aborted materials

Onehundred-and-fourty fetuses from 99 goats were examined. Foetal membranes were rarely found, and only 7 were available for examination. Vaginal fluids were collected on cotton swabs in transport medium (Swab transport pack, Amies medium, Difco) from 61 goats that had aborted or were suspected of having aborted.

Laboratory examinations of aborted materials

Besides gross inspection, fetuses and foetal membranes in a reasonable state of preservation were examined for *Toxoplasma gondii* as described by *Waldeland* (1976a).

Abomasal contents were routinely examined at 320X with a phase contrast microscope. Cultures from brain, lung, heart, liver and abomasal contents were made on 7 % sheep blood agar and incubated aerobically at 37°C for 48 h. Cultures were also made on blood agar and on chocolate agar and incubated at 37°C in an atmosphere of 10 % CO_2. From small and partly mummified fetuses only the brain and/or abdomen were examined bacteriologically. Cultures for mycological examinations were made on Sabouraud's agar.

Serological examinations

All blood samples collected after delivery were examined for antibodies against *T. gondii* by either an indirect haemagglutination method (HA-kit, bio-Merieux), or a micromodification of the Sabin-Feldman dye test (*Waldeland* 1976b). Samples collected in December were examined only if the goats had positive titers ($\geq$ 1/16) after delivery, to find individuals with seroconversion during pregnancy and to learn whether this was associated with reproductive loss in the individual or in the flock. Samples from goats that aborted or were barren and samples selected at random among those collected after the kidding were tested for neutralizing antibodies against the cytopathogenic NADL strain of bovine pestivirus and a Norwegian isolate of caprine herpes virus[1] in neutralization tests (*Løken et al.* 1982), and for antibodies against commercially available antigens of *Chlamydia psittaci* (Ornithosis antigen[2]) and *Coxiella burnetii* (Q-fever antigen[2]), respectively. The numbers examined in each of the 4 latter tests are recorded in Table 1.

Samples from 53 goats that aborted were also examined for antibodies against *Leptospira interrogans var. pomona* and *var. icterohemorrhagiae* with a direct agglutination test[3].

Sera from all goats that aborted were examined for antibodies to placental antigens by a diffusion-in-gel enzyme-linked immunosorbent assay (DIG-ELISA) performed as described by *Elwing & Nygren* (1979). Positive control antiserum to goat placental antigens was prepared by repeated (3 times) subcu-

[1] Kindly supplied by Bj. Hyllseth, Norwegian College of Veterinary Medicine.

[2] Behringwerke AG, Marburg, W. Germany.

[3] Kindly performed by Ø. Ødegaard, National Veterinary Institute, Norway.

taneous injection of goat placental tissue in saline into an 8 months old sheep. The control serum was collected 3 weeks after the last injection, and aliquots of the serum were stored at –20°C until required. Placental antigen for the test was prepared from fresh placentas collected immediately after expulsion from goats with a normal pregnancy. The placentas were washed in sterile phosphate-buffered saline (PBS, pH 7.2). Cotyledons were minced in PBS, and placental cells were disrupted with an ultrasonic homogenizer (Cole-Parmer Instruments Co.). The suspension was strained through muslin, and adjusted to a protein concentration of 5 µg/ml.

Examinations for mycotoxins and toxin-producing fungi

Seven samples of grass silage and 4 samples of concentrates from a total of 8 farms were examined for zearalenone[4] and for toxin-producing fungi[5].

Results

Of the 2370 goats, 369 (15.6 %) either aborted or delivered dead kids at full term, or were barren. In 1 herd, all of 54 mated goats had live kids. In the 23 other herds, the rate of goats with reproductive loss varied from 2 % to 36 %. A rate of ≥ 20 % was found in 9 flocks with a total of 799 goats. In 11 herds comprising 946 goats the rate of loss was ≤ 10 %. Most of the abortions occurred during the last 6–8 weeks of pregnancy. In 9 of the 13 herds with a loss of ≥ 10 %, mainly goats ≥ 3 years old were affected, whereas reproductive failure occurred within all age groups in the 4 remaining herds.

Gross examination of aborted fetuses

Of the 140 fetuses submitted for examination, only 11 had a fresh appearance when examined. Seven of these were aborted together with a mummified or an oedematous, autolyzed twin. The 4 remaining fetuses were aborted from 4 goats in 3 different herds, in which from 3 to 8 other goats aborted mummified or oedematous fetuses. Fifty-six of the fetuses were oedematous, whereas 73 were mummified in varying degree. Each of 7 goats had 1 mummified and 1 oedematous fetus. The oedema was blood-stained, and these fetuses also had bloody fluid in their thoracal cavities. The degree of decomposition varied.

Of the 7 foetal membranes received, 6 were from goats with mummified fetuses. One membrane that was relatively fresh, accompanied an oedematous fetus that was delivered at full term together with a live twin. No other goats in this herd aborted or delivered dead kids.

Microbiological and serological examinations

Listeria monocytogenes was isolated from 8 fetuses from 5 herds. In 1 of these herds the bacterium was isolated from all fetuses of the 3 goats that aborted. In the 4 other herds, Listeria monocytogenes was detected in only odd cases. *Clostridium perfringens* was isolated from 1 fetus, and from the vaginal fluids from a ewe from another herd. *T. gondii* was isolated from 1 fetus from a herd where 4 of 54 goats aborted. No evidence was found of microfungi or mycotoxins as causes of abortion. Antibodies against placental tissue were not detected. The results from the other examinations of serum collected after kidding was terminated are shown in Table 1.

Of the 366 goats serologically positive to *T. gondii,* 62 were negative at the first samp-

[4] Kindly performed by M. Yndestad, Norwegian College of Veterinary Medicine.

[5] Kindly performed by H. Stenwig, National Veterinary Institute, Norway.

Table 1. Serological examinations of goats in 24 different herds during pregnancy.

Micro-organism	Number examined	Number positive
Toxoplasma gondii[1]	2193	366
Pestivirus[2]	2073	7
Caprine herpesvirus[2]	2030	379
Chlamydia psittaci[3]	554	6
Coxiella burnetii[3]	25	0
Leptospira interrogans[4] var. icterohemorrhagiae and pomona	53	3

[1] 1894 samples by the hemagglutination test and 299 by the Sabin-Feldman dye test.
[2] Neutralization test.
[3] Complement fixation test.
[4] Direct agglutination test.

ling in December. None of these aborted or were barren. Three goats that aborted had titers of ≥ 1/1024 at the examination in both December and the following spring, and at the time of abortion.

The 7 goats positive for pestivirus antibodies were from 4 different herds. Their titers ranged from 1/4 to 1/128. None of these goats aborted.

The 379 goats positive in the test for herpesvirus antibodies were from 15 herds. The maximum titer was 1/64. The reproductive problems were not associated with positive tests to herpesvirus.

Low antibody titers against Chlamydia were found in 6 goats, none of which had aborted.

The antibody titers of the 3 goats positive to Leptospira spp. ranged from 1/10 to 1/30. Two of the goats belonged to a herd in which a total of 43 of 150 goats aborted, and 1 to a herd where 27 of 87 aborted. Eight other aborting goats examined in each of these herds were negative.

Discussion

Most of the flocks were selected among herds that had problems with reproductive failures. It is therefore not surprising that the rate of abortion found in the present investigation was higher than previously reported in this country (*Melby et al.* 1985, *Løken* 1990).

An etiological diagnosis was made in only 10 (2.7 %) of the 369 goats that aborted or were barren. In these few cases diagnosed, listeric infection was the most prevalent cause. In sheep in Norway toxoplasmosis has been diagnosed as being present in about 80 % of the abortions (*Waldeland* 1976a). Outbreaks of Toxoplasma abortion have been diagnosed also in goats. Thus, 98 of 111 goats aborted from toxoplasmosis on a neighbouring farm of 1 of the herds that participated in the present investigation. It was therefore surprising that *T. gondii* was recovered from only 1 of the 140 fetuses and that only 3 goats had antibody titers (≥ 1/1024) at a level that in sheep indicates Toxoplasma abortion (*Waldeland* 1977).

None of the 62 goats that were negative on the first sampling and positive in the spring aborted. This indicates that the infection took place at a late stage of gestation with no harmful consequences for the fetus. However, due to reasons out of our control the investigation was not started before December when most of the goats were in their 3rd or 4th month of pregnancy, and infection inducing antibody production may therefore have occurred during pregnancy before the first sampling when a total of 366 goats were found to have antibodies against *T. gondii.* In such cases, however, high titers in many of the goats that aborted and also in other goats in the herd should be expected. In the present work 3 goats had high titers (≥ 1/1024) indicating toxoplasmosis as a probable cause of abortion. These goats also

had high titers when examined in December. It should be mentioned that high titers that indicated an earlier infection and possibly toxoplasmosis as cause of previous abortion, were found in 1 flock that had a normal reproductive performance, but in which 40 % of the does aborted the year before. It is possible that toxoplasmosis was the cause of abortion that year and accordingly that high antibody titers are produced following abortion and remain high for a long period in goats as well as in sheep (*Waldeland* 1977).

Since antibodies against the other 5 infectious agents were not associated with reproductive failures, such examinations of serum collected earlier during pregnancy were not carried out.

It is possible that early foetal death or abortion might have occurred from listeric or other infections in some barren goats. But this can not alter the fact that the majority of reproductive failures must have been due to unknown causes. The occurrence of abortions during successive seasons in the same herds, mainly among older goats and, as observed by some farmers, often in the same individuals, indicates that these causes may be non-infectious. An immunological rejection as demonstrated by *Corbel* (1972) in ewes experimentally infected with *Aspergillus fumigatus* could fit in with repetitive abortions among older goats. However, in the present study the examination for placental antibodies was negative.

In the present work, facilities for an extensive mycological examination were not available. A few samples of grass silage and concentrates from 7 herds were examined for zearalenone and toxinproducing fungi with negative results, but this is not sufficient to rule out mycotoxins as a possible cause of abortion. The toxin production of fungi depends upon temperature and moisture, and frequent samples should therefore be examined from both grass silage and concentrates.

In contrast to sheep, goats depend upon the presence of corpus luteum to maintain pregnancy. In the Angora goat, a low blood glucose level seems to be a triggering mechanism for regression of corpus luteum and abortion (*Wentzel* 1982). In some herds in the present investigation a similar cause of abortion could be expected, since the concentrate ration was reduced to terminate lactation. However, in the work by *Wentzel et al.* (1974, 1974, 1976) fetuses aborted following undernutrition and hypoglycaemia were non-oedematous, and were alive up to the time of expulsion. In the present material, only 11 of the fetuses examined were aborted in a non-oedematous fresh state, and of these, 7 had an oedematous or mummified twin.

Most abortions occurred in goats that had a normal first pregnancy and usually also a normal second pregnancy. Some farmers also reported that goats that had aborted once, tended to abort again during following pregnancies. Together with the fact that the majority of fetuses were either oedematous or in various states of mummification, these observations indicate a similar etiology as described in habitual aborters in the Angora goat, where abortion is thought to be induced by hyperadrenalism on a hereditary basis (*Van Rensburg* 1971, *Wentzel et al.* 1975). Further investigations are required to examine the importance of hyperadrenalism in Norwegian goats. However, there is little reason to believe that genetic differences are so large between herds in the same area that an exclusively hereditary basis for abortion occurring in 1 herd and not in neighbouring herds may be likely. Most herds participate in a co-operative breeding scheme. This is designed to overcome difficulties in obtaining a reasonable progeny test when herds are

small by getting neighbouring farmers to form a buck circle of about 10 herds, where each buck serves at least 60 goats evenly distributed on the different herds. Since the herds are small, a great exchange of breeding animals between herds occurred also before the breeding circle scheme was established. Therefore, the genetic material may largely be the same in herds with an abortion problem as in herds without such a problem. However, a genetic basis for the abortion problem, which in addition may be associated with nutritional and/or environmental factors can not be ruled out.

In conclusion, none of the infections studied in the present investigation were of any major importance as causes of reproductive loss. Furthermore, the pattern of abortion seems to contradict infectious causes. Abortion on an hereditary basis such as from hyperadrenalism in the Angora goat seems unlikely but needs to be investigated. In abortion from regression of corpus luteum following subnutrition as demonstrated in the Angora goat, the foetus is alive up to the time of abortion and accordingly expelled in a fresh state. In the present investigation the majority of foetuses were either oedematous or in varying states of mummification. However, further work should be undertaken to elucidate the influence of multiple adverse nutritional and/or environmental factors.

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Sammendrag

Reproduksjonstap hos geit i Norge.
En undersøkelse i 24 besetninger.

Undersøkelsen ble foretatt i den vestlige del av Norge i 24 besetninger med i alt 2370 geiter. Av disse var det 369 (15.6 %) som enten aborterte eller fødte døde kje, eller som var tomme. I 23 av besetningene varierte tapsprosenten mellom 2 og

36, mens i en besetning fikk alle geitene levende kje. I 9 besetninger med totalt 799 geiter var det minst 20 % som ikke fikk levedyktige kje. I 11 besetninger med 946 geiter var tapet på grunn av drektighetsforstyrrelser $\leq$ 10 %. Abort forekom med større hyppighet hos eldre geiter enn hos geiter som kjeet for første eller anden gang. Årsaken ble påvist i bare ca. 3 % av tilfellene. Konklusjonen er at reproduksjonsproblemet i mange flokker sannsynligvis har samband med ikke-infeksiøse faktorer som ernæring og miljø.

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