

7. The way forward to official paratuberculosis free status: national surveillance, diagnostic, disease control and management programme for paratuberculosis in Norway 2016-2021

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7.1. Abstract

Historically, paratuberculosis was endemic in Norway in herds of goat and cattle. The annual national surveillance programme for paratuberculosis was established in Norway in 1996. During the last six years (2016-2021) of surveillance, more than 29 000 samples were analysed for *Mycobacterium avium* subsp. *paratuberculosis* (MAP) infection. MAP has not been detected in Norway since 2015. An effective surveillance, diagnostic and management programme substantially contributed to the control of paratuberculosis in Norway. The transition from MAP endemic status to having no known positive cases of paratuberculosis in Norway is a remarkable success. This could set the scene for Norway to become an “Officially Paratuberculosis Free” country.

7.2. Introduction

In Norway, the first *Mycobacterium avium* subsp. *paratuberculosis* (MAP) infection was reported in cattle in 1907 (Horne, 1908) followed by detection in goats in 1934 (Holmboe and Slagsvold, 1934). The presence of MAP in sheep was first reported in 2002 (Nyberg and Djønne, 2003) and recently in alpaca in 2014 (Kampen et al., 2014).

Paratuberculosis in ruminants (Johne's disease) is a national List 2 disease in Norway, and thus mandatory notifiable. Government legislation enforces the control of paratuberculosis and includes restrictions on animal movement (Norwegian Food Safety Authority, 2022). National programmes have been implemented to control and eventually to eradicate this disease in Norway (Whittington et al., 2019).

Historically, infected domestic goat and cattle herds and the import of live animals were the main risk factors for paratuberculosis in Norway (Djønne et al., 2002). In goat herds, government restrictions on animal movement combined with vaccination, were previously used to control paratuberculosis (Djønne et al., 2002). Vaccination against MAP is now prohibited in Norway. An annual national surveillance programme for paratuberculosis in cattle was established in 1996 (Djønne et al., 2001). During 2000-2002, other ruminants such as camelids, goats and sheep were included in the annual national surveillance programme for paratuberculosis (Djønne et al., 2002). During 2001-2015, a large proportion of the Norwegian goat herds underwent major diseases eradication programme called "Healthier goats", in which paratuberculosis was included (TINE Rådgiving and Helsetjenesten for geit, 2016).

There are two institutes performing MAP surveillance in Norway. The Norwegian Veterinary Institute analyses faecal and organ samples collected by the Norwegian Food Safety Authority in the MAP surveillance programme, and TINE Norwegian Dairies perform serological surveillance on caprine, sheep and bovine milk and serum.

The status of MAP surveillance in Norway, with a focus on the Norwegian healthier goat project, was published in 2016 (Lindheim et al., 2016). This current report presents a summary of the national surveillance, diagnostic and management programme for paratuberculosis in Norway during 2016-2021.

7.3. Materials and Methods

MAP surveillance at the Norwegian Veterinary Institute

The Norwegian Food Safety Authority commissions the Norwegian Veterinary Institute to conduct the MAP surveillance programme. Between 2016-2021, a total of 12 374 faecal and organ samples (Table 1) from more than 2 300 herds of cattle, goats, camelids and sheep flocks were included in the surveillance programme. Faecal samples were collected at farms as active surveillance. Additionally, the Norwegian Food Safety Authority collected organ samples for the passive clinical surveillance on clinical suspicion at the farm or at slaughterhouses. All samples were analysed at the Norwegian Veterinary Institute.

Table 1. Number of faecal or tissue samples analysed for *Mycobacterium avium* subsp. *paratuberculosis* during 2016-2021.

Year	Cattle	Goats	Sheep	Camelids
2016	457 (92)	1 113 (118)	350 (40)	686 (203)
2017	476 (94)	1 031 (126)	370 (37)	587 (181)
2018	461 (93)	983 (124)	413 (42)	621 (195)
2019	475 (97)	701 (86)	290 (29)	668 (229)
2020	941 (189)	558 (64)		3 (3)
2021	931 (187)			259 (90)
Total	3 741 (752)	4 386 (518)	1 423 (148)	2 824 (901)

Nucleic acids from faecal samples were analysed by real-time PCR using the ADIAVET ® REALTIME PARATB kit (BioX). This test is based on the amplification of the DNA segment IS900 target present in multiple copies within the MAP genome. Organ samples were screened for macroscopic pathological and histopathological changes. In addition, bacteriological confirmatory diagnostic tests were performed.

MAP surveillance at TINE Norwegian Dairies

The surveillance programme at the TINE Norwegian Dairies is based on antibody detection in serum and milk samples (individual and bulk). Between 2016-2021, 17 443 samples from goats, sheep and cattle were analysed (Table 2).

Table 2. Number of milk and serum samples analysed for *Mycobacterium avium* subsp. *paratuberculosis* antibodies using immuno-assay methods during 2016-2021.

Year	Goats	Sheep	Cattle
2016	1 692	414	
2017	1 778	304	
2018	2 484	104	
2019	2 264	410	
2020	1 817	121	
2021	1 749	310	3 996
Total	11 784	1 663	3 996

7.4. Results

During 2016-2021, more than 12 300 faecal and organ samples collected from more than 2 300 herds of cattle, goats, camelids and sheep flocks were analysed. Paratuberculosis was not detected in any of the samples. During the same period, 17 443 milk and serum samples were analysed, and 14 serum samples were positive for MAP antibodies. All 14 MAP-positive

serum reactor samples were from goats analysed in 2016 (Table 3). There have not been any MAP-positive reactor animal reported in Norway since then.

Table 3. Milk and serum samples analysed for *Mycobacterium avium* subsp. *paratuberculosis* antibodies using immuno-assay method (MVD-Enferplex™ Goat/Sheep Multi-Disease, 01H12) in 2016.

Animal species	Sample type	Number of analysed samples	Number of positive samples
Goat	Individual milk	62	0
Goat	Serum	527	14
Goat	Bulk-tank milk	1 103	0
Sheep	Serum	414	0

Norway increased the import of hay/silage from abroad in 2018. As part of follow-up diseases control, 3996 bulk-tank cattle milk samples were analysed for MAP antibodies (IDEXX Paratuberculosis Verification Ab Test). None of the samples was positive for antibodies against MAP.

7.5. Discussion

Mycobacterium avium subsp. *paratuberculosis* (MAP) has not been detected in Norway since 2015. There were 14 MAP antibody-positive goats reported in 2016, but they were from a single herd that had received vaccination against MAP.

Previously, paratuberculosis in goats had been detected in five of the 11 counties in Norway. All the cases among cattle and sheep were traced to imported animals or had contacts with infected domestic goats (Kampen et al., 2022). Importation of live cattle has been very limited and herd/flock replenishment have largely been replaced by the import of semen and embryos.

The Norwegian Goat Health Services and the dairy organization (TINE) had conducted a diseases eradication programme named “Healthier goats” from 2001 to 2015. The “Healthier goats” programme targeted three infectious diseases that were previously widespread in goats; paratuberculosis, caprine arthritis encephalitis and caseous lymphadenitis (TINE Rådgiving and Helsetjenesten for geit, 2016). The programme had significantly contributed to the control and eradication of paratuberculosis particularly in goats (Lindheim et al., 2016; Kampen et al., 2022).

During the last six years (2016-2021) of surveillance, no MAP-positive animal was detected in Norway. Similarly, low prevalence (<1%) of paratuberculosis in ruminants has been reported in Sweden (Whittington et al., 2022). Hence, both countries are unique globally in having no known positive cases of paratuberculosis. This can pave the way to attain internationally recognised “Officially Paratuberculosis Free” status.

The national surveillance and eradication programme has reduced the local source of MAP infection to a point below detection limits. However, there is still a possibility of undetected

infected animals that might pose a risk as source for new infections. Furthermore, the ongoing importations of live animals llamas and alpacas, as well as the import of animal feed (for example, hay/silage), could also present risks for re-introduction of MAP infection into the Norwegian ruminant population (Kampen et al., 2022). Continual surveillance, diagnostics and management programmes for MAP are key to preserving today's situation in Norway.

7.6. References

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