Annual Report

# The surveillance programme for feed materials, complete and complementary feed in Norway 2017 - Mycotoxins, fungi

Veterinærinstituttet
Norwegian Veterinary Institute

Mattilsynet

# The surveillance programme for feed materials, complete and complementary feed in Norway 2017 – Mycotoxins and fungi

## Content




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## Summary

In 2017 various mycotoxins and fungi were measured in oats and barley, aflatoxins were measured in maize and in compound feed for ruminants, and various mycotoxins were measured in compound feed for pig and dog. Concerning fungi, in total 30% of oat samples showed total mould above guidance value for acceptable level (500,000 cfu/g). Considerably lower levels of mould were found in barley with only 2% of the samples above guidance value.

Oats had higher levels of trichothecene mycotoxins than barely. Deoxynivalenol (DON) and T-2 toxin (T-2) + HT-2 toxin (HT-2) were the major trichothecenes detected. However, the level of DON was at the lower end of the range measured in cereal grain during the last 16 years. However, also certain levels of DON-related compounds were found, and these compounds showed significant positive correlation with DON. Compared with previous years, the sum of T-2+HT-2 showed moderate concentrations. *Z*earalenone (ZEN) was only detected in a few cereal samples and far below the recommended limit in feed materials. Ergot alkaloids were hardly detected in oats but sporadically found at levels of possible concern in barley.

Traces of aflatoxins were found in maize, but no aflatoxins were detected in complementary compound feed for ruminants. The analysis of aflatoxins is mainly to have control of the risk for occurrence of aflatoxin metabolites in animal products for human consumption.

In compound feed for pig, DON was detected in most samples but all below the recommended limit. DON-related compounds were detected in several samples at lower levels than DON but these compounds contributed considerably to total DON. T-2 and HT-2 were present in several samples below recommended limit. ZEN was detected in some samples at low levels. In compound feed for dog, DON was found in some samples without any detection of related compounds, ZEN was found in some samples, and T-2+HT-2 were present sporadically, all below recommended limits. Compound feed for pig and dog were also analysed for ochratoxin A (OTA) without detection, but the level of detection was relatively high. Ergot alkaloids were sporadically present in compound feed for pig and dog at a level considered to be of concern but the toxicological knowledge base for risk assessment is very limited.



## Sammendrag på norsk

I 2017 ble forskjellige mykotoksiner og sopp målt i havre og bygg, aflatoksiner ble målt i mais og i kraftfôr til drøvtyggere, og forskjellige mykotoksiner ble målt i kraftfôr/tørrfôr til gris og hund. Når det gjelder sopp, viste totalt 30 % av havreprøvene total mugg over veiledende grenseverdi for hva som vanligvis aksepteres (500.000 kde/g). Det ble funnet lavere nivåer av mugg i bygg, der 2 % av prøvene oversteg veiledende grenseverdi.

Havre hadde høyere nivåer av trikotecen-mykotoksiner enn bygg. Deoksynivalenol (DON) og T-2-toksin (T-2) + HT-2-toksin (HT-2) var de viktigste trikotecenene som ble påvist. Nivået av DON i kornet var imidlertid lavere enn det man vanligvis har sett ved slike undersøkelser gjennom de siste 16 årene. Men det ble også påvist DON-relaterte forbindelser i relativt betydelige konsentrasjoner i kornet, og disse samvarierte med DON. Sammenlignet med tidligere år viste summen av T-2 + HT-2 moderate konsentrasjoner. Zearalenon (ZEN) ble bare påvist i noen få kornprøver og langt under anbefalt grense i fôrmidler. Meldrøye-alkaloider ble nesten ikke påvist i havre, men sporadisk funnet i bygg i nivåer som gir grunn til mulig bekymring.

Spor av aflatoksiner ble funnet i mais, men ingen aflatoksiner ble påvist i kraftfôr til drøvtyggere. Analysene av aflatoksiner er hovedsakelig begrunnet ut fra viktigheten av å overvåke risikoen for forekomst av aflatoksinmetabolitter i animalske produkter til konsum.

I kraftfôr til gris ble DON påvist i de fleste prøvene, men alle under anbefalt grense. DON-relaterte forbindelser ble påvist i flere prøver. Konsentrasjonene av dem var lavere enn av DON, men de bidro betydelig til total konsentrasjon av DON. T-2 og HT-2 ble påvist i flere prøver – alle under anbefalt grense.

ZEN ble påvist i noen prøver i lave nivåer. I tørrfôr til hund ble DON funnet i noen prøver under anbefalt grense, og her fant man ingen av de relaterte forbindelsene. ZEN og T-2 + HT-2 ble påvist i enkelte prøver under anbefalte grenser i hundefôret. Kraftfôr/tørrfôr til gris og hund ble også analysert for okratoksin A uten påvisning, men her var påvisningsgrensen relativt høy. Meldrøye-alkaloider ble påvist sporadisk i kraftfôr/tørrfôr til gris og hund på et nivå som kan gi grunn til bekymring, men kunnskapsgrunnlaget for risikovurdering av dem er svært begrenset.

## Introduction

The surveillance programme for mycotoxins and fungi in feed materials and complete feed is a collaboration between the Norwegian Food Safety Authority (NFSA) and the Norwegian Veterinary Institute (NVI) where NFSA decides the extent of the programme based on scientific advices from NVI. NFSA is responsible for collecting the samples and NVI for analysing and reporting of the results.

Genus *Fusarium* is considered as the most important mycotoxin-producing moulds primarily infecting cereals in the field during the growing season. They produce important mycotoxins like trichothecenes deoxynivalenol (DON), T-2 toxin (T-2) and HT-2 toxin (HT-2), as well as zearalenone (ZEN). Two decades of surveillance in Norwegian cereals have found DON to occur in high concentrations, particularly in oats and wheat. DON is considered as a health risk when ingested by animals and humans (1). Exposure to DON causing gastrointestinal signs such as reduced feed intake and growth rate are well documented in pigs. T-2 and HT-2 levels of concern are usually present only in oats and oat products. T-2 and HT-2 have similar but potentially stronger toxic effect than DON, in causing gastrointestinal lesions as well as immune suppression (1). The oestrogenic mycotoxin ZEN is produced by the same *Fusarium* species as DON, but its level has been insignificant in Norwegian cereals based on limited available occurrence data (1).

Ergot alkaloids are emerging mycotoxins of considerable interest in EU and data on their occurrence are of great interest (2). They cause moderate acute toxicity, such as produce neurotoxicity, inhibit blood circulation and can interfere with hormone levels. The producer of ergot alkaloids, *Claviceps purpurea*, is mainly found in rye.

Species of genera *Penicillium* and *Aspergillus* are the most important mycotoxin-producing moulds that infect cereals and feed primarily during storage. *Penicillium* species that generally grow and produce mycotoxins at lower temperatures than species of *Aspergillus*, are therefore the main concern under Norwegian storage conditions. Ochratoxin A (OTA) is an important mycotoxin produced by several species of both *Penicillium* and *Aspergillus* worldwide. The most prominent livestock effect of OTA is nephrotoxicity in pigs. The toxin may also suppress the immune function and performance (1). So far, OTA has not caused problems for Norwegian husbandry. Nevertheless, active surveillance of OTA is important because its potential risk and occurrence in imported feed ingredients is unpredictable (1). Aflatoxins, produced by some Aspergilli, are considered a possible import problem for Norway. To minimize the human health risk via consumption of animal products, the carcinogenic and liver toxic aflatoxins in feed must be kept at low levels. Case in point is that aflatoxins in feed for dairy cattle can lead to the presence of an active aflatoxin metabolite in milk.

## Aims

The aims of the programme are to provide reliable documentation on the occurrence of important mycotoxins and selected fungi in feed cereal materials, and complete and complementary feed in Norway, and to use the data to assess adverse animal health risks related to these agents in feed and to human exposure of transmissible agents via animal products.

## Materials and methods

In 2017, the surveillance programme for feed consisted of the following samples received at NVI and analysed for various agents:

- 92 samples of small cereal grain consisting of oats (46) and barley (46),
- 10 samples of maize/maize gluten,
- 50 samples of complementary compound feed for ruminants,
- 20 samples of complete compound feed for pigs,
- 25 samples of complete compound feed for dogs.

The analysed number of small cereal grains, maize and feed for pigs were somewhat below the plan, whereas the analysed number of samples of feed for ruminants and dogs followed the plan exactly.

The samples were collected by NFSA according to the sampling plan. Small grain samples collected at mills in grain production areas were sent to NVI during autumn. Maize collected from batches imported from 3rd countries, samples of compound feed for ruminants and pigs collected from the feed industries, and samples of compound feed for dogs from pet stores were all received by NVI throughout the year. Sampling was according to EU Regulation 691/2013 to ensure samples were representative. Sampling procedures considered factors such as size/volume of the lot to be sampled, uniformity in distribution of the substances to be analysed, number of incremental samples, sampling tools, size of final samples etc.

All samples were analysed at NVI. The samples of cereal grain (oats, barley) were analysed for total mould, *Fusarium,* storage mould, and yeast, and selected mycotoxins which include trichothecenes, ZEN and ergot alkaloids. The maize samples and the samples of compound feed for ruminants were analysed for aflatoxins. The compound feed for pigs and dogs were analysed for trichothecenes, ZEN, OTA and ergot alkaloids.

### Quantitative determination of total mould, *Fusarium*, storage fungi and yeast

Quantitative determinations by NMKL method No 98 of mould, *Fusarium* and storage fungi in oats and barley were done using only Malt-yeast-extract-sucrose-agar (MYSA) as growth medium. In addition to the total amount of mould, a qualitative determination of the composition of the mycoflora was examined. *Fusarium*, storage fungi and yeast were counted separately. The detection limit for mould, *Fusarium*, storage fungi and yeast in feed is 50 colony forming units per gram (cfu/g).

### Chemical analysis

The novel multi-mycotoxin liquid chromatography–high-resolution mass spectrometry (LC-HRMS/MS) method was applied for the simultaneous determination of selected mycotoxins in the various cereal samples (3). The developed LC-HRMS/MS multi-mycotoxin method was 'in house' validated in order to ensure the quality and reliability of collected data. The performance parameters linearity, selectivity, limit of detection (LODs) and limit of quantifications (LOQs) were assessed. According to the data collected in 2016, considerable matrix effects were demonstrated for all selected mycotoxins, varying from 64% to 148%. Reasonable levels of signal suppression or signal enhancement were achieved for only 30% of targeted mycotoxins. Therefore, in order to improve the accuracy of the method, we introduced stable-isotope labelled internal standards (IS) for nine of the analysed mycotoxins including DON, 3-acetyl-DON (3-Ac-DON), 15-acetyl-DON (15-Ac-DON), DON-3-glucoside (DON-3-G), nivalenol (NIV), HT-2, T-2, ZEN and OTA. For quantitative analysis of ergot alkaloids, a semisynthetic ergot derivatives were used for the preparation of IS calibrations. Statistics from proficiency test that was provided for the national reference laboratories (NRLS) and appointed official control laboratories (OCLS) confirmed the applicability of this approach. Accuracy of the method was determined by spiking studies. Bias was expressed as analytical recovery. The extraction methodology was based on the two-step extraction (MeCN:H2O:HCOOH, 80:19.9:0.1, v/v/v and MeCN:H2O:HCOOH, 20:79.9:0.1, v/v/v) in order to improve extraction with respect to polar and non-polar compounds.

LC-HRMS analyses were performed on a Q-Exactive™ Hybrid Quadrupole-Orbitrap mass spectrometer equipped with a heated electrospray ion source (HESI-II) and coupled to an UHPLC Dionex Ultimate 3000 system (Thermo FisherScientific).

*Analytes and limit of detections*
DON: 66 µg/kg, 3-Ac-DON: 16 µg/kg, 15-Ac-DON: 52 µg/kg, DON-3-G: 80 µg/kg, T-2: 14 µg/kg, HT-2: 22 µg/kg, NIV: 30 µg/kg, ZEN: 10 µg/kg, OTA 21 µg/kg, ergonovine: 56 µg/kg, ergosine: 12 µg/kg, ergotamine: 40 µg/kg, ergocornine: 12 µg/kg, alpha-ergocryptin: 190 µg/kg, ergocristin: 24 µg/kg.

Aflatoxins (B1, B2, G1, G2) were analysed using immunoaffinity columns clean up followed by determination by HPLC using fluorescence detection after post-column derivatisation. The detection limit for aflatoxins were: B1: 0.25 µg/kg, B2: 0.10 µg/kg, G1: 0.20 µg/kg, G2: 0.15 µg/kg.

### Statistical analysis

Descriptive statistics using mean and standard deviation were employed to estimate the true population mean and variance for the various agents with levels measured in a quantitative manner. Categorical linear regression was used to determine significance in statistical difference between groups, the independent variables (cereals, regions), for the same agents, (the dependent variables). To investigate possible linear correlation between two contaminants in the same feed type, Pearson correlation and regression coefficients were estimated and their p value determined. Half detection limits were used for calculation purposes.

## Results and discussion

### Cereals

*Levels of fungi in oats and barley*
In oats, the concentrations of total mould were above guidance value (500,000 cfu/g) (4) in 30% of the samples indicating poor hygienic quality (Table 1). However, since the samples were fresh grain from the field and not sufficiently dried, the results concerning total mould should be emphasized milder. Poor hygienic quality, however, if used as is, may cause reduced growth and health problems in animals (5). Storage mould was found in several samples of oats, but only three samples (7%) above guidance value (100,000 cfu/g). Barley had significantly less total mould and storage mould than oats (p-values <0.0001 and =0.04, respectively). The concentrations of total *Fusarium* and yeast were not significantly different between the cereal species, and no samples were above the guidance value for yeast (10,000,000 cfu/g).

The levels of total mould and total *Fusarium* were significantly positively correlated in oats and barley (Table 2). Total *Fusarium* is certainly included in total mould, which facilitate such a relation, but total *Fusarium* constitute only a few percent of total mould. In addition, *Fusarium* and yeast were positively correlated (significantly only for oats, Table 2). Storage mould, however, was not correlated with the other fungi but the tendency was inverse relations.

Table 3 shows the frequency of *Fusarium* species determined in oats and barley. *F. graminearum and F. langsethiae*, the producers of DON and T-2+HT-2, respectively, were the most dominating species in oats. Barley showed a different pattern of *Fusarium* species dominated by *F. tricinctum* and *F. avenaceum* which do not produce trichothecenes, but less important mycotoxins such as moniliformin and enniatins and others (1).

**Table 1.** Concentrations (cfu/g) of fungi (total mould, total *Fusarium*, storage fungi and yeast) and concentrations (µg/kg) of trichothecenes (deoxynivalenol (DON), 3-acetyl-DON (3-Ac-DON), 15-acetyl-DON (15-Ac-DON), DON-3-glucoside (DON-3-G), sum of HT-2 and T-2 toxin, nivalenol (NIV)) and zearalenone (ZEN) in oats and barley sampled in Norway in 2017.

| | Total mould | Total *Fusarium* | Storage fungi | Yeast | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2+ HT-2 | NIV | ZEN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oats** (n = 46) | | | | | | | | | | | |
| Mean | 600 000 | 21 200 | 14 800 | 490 000 | 241 | 39 | <52 | <80 | 184 | <30 | <10 |
| Median | 355 000 | 12 500 | <50 | 190 000 | 164 | 20 | <52 | <80 | 144 | <30 | <10 |
| Min / max | 21 000 / 3 000 000 | <50 / 100 000 | <50 / 230 000 | <50 / 3 300 000 | <66 / 1028 | <16 / 373 | <52 | <80 / 628 | <36 / 593 | <30 / 298 | <10 / 136 |
| St. deviation | 696 000 | 22 800 | 50 145 | 682 678 | 241 | 61 | 0 | 115 | 157 | 44 | 22 |
| % samples above detection limit | 100 | 96 | 28 | 98 | 70 | 57 | 0 | 20 | 80 | 11 | 4 |
| % samples above guidance values | 30 | | 7 | 0 | 0 | | | | 2 | | 0 |
| **Barley** (n = 46) | | | | | | | | | | | |
| Mean | 142 000 | 13 000 | 2 900 | 419 000 | 88 | <16 | <52 | <80 | <36 | <30 | <10 |
| Median | 105 000 | 5 700 | <50 | 255 000 | <66 | <16 | <52 | <80 | <36 | <30 | <10 |
| Min / max | 2 000 / 860 000 | 100 / 100 000 | <50 / 41 000 | 17 000 / 1 900 000 | <66 / 732 | <16 / 136 | <52 | <80 / 414 | <36 / 227 | <30 / 32 | <10 / 79 |
| St. deviation | 151 000 | 17 600 | 7 300 | 416 000 | 136 | 22 | 0 | 60 | 37 | 3 | 11 |
| % samples above detection limit | 100 | 100 | 37 | 100 | 24 | 17 | 0 | 11 | 15 | 2 | 9 |
| % samples above guidance values | 2 | | 0 | 0 | 0 | | | | 0 | | 0 |

**Table 2.** Correlation coefficients between concentrations of the various groups of fungi in oats and barley sampled in Norway in 2017. Significant correlation coefficients are presented in **bold** ($p<0.05$, $r>0.291$).

| | Total mould | Total *Fusarium* | Storage fungi | Yeast |
|---|---|---|---|---|
| Oats (n = 46) | | | | |
| Total mould | 1.000 | | | |
| Total *Fusarium* | **0.577** | 1.000 | | |
| Storage fungi | -0.107 | -0.193 | 1.000 | |
| Yeast | **0.668** | **0.416** | -0.162 | 1.000 |
| Barley (n = 46) | | | | |
| Total mould | 1.000 | | | |
| Total *Fusarium* | **0.720** | 1.000 | | |
| Storage fungi | -0.047 | -0.096 | 1.000 | |
| Yeast | **0.513** | 0.201 | -0.089 | 1.000 |

**Table 3**. The frequency of *Fusarium* species found in oats and barley in 2017.

| Species | Number of samples (and %) detected | Number of samples with most dominant species |
|---|---|---|
| **Oats (n = 46)** | | |
| *F. graminearum* | 19 (41 %) | 11 |
| *F. langsethiae* | 17 (37 %) | 11 |
| *F. poae* | 15 (33 %) | 9 |
| *F. avenaceum* | 14 (30 %) | 6 |
| *F. tricinctum* | 11 (24 %) | 5 |
| *Microdochium seminicola* | 1 (2 %) | 1 |
| No *Fusarium* occurrence | 3 (7 %) | |
| **Barley (n = 46)** | | |
| *F. tricinctum* | 25 (54 %) | 12 |
| *F. avenaceum* | 23 (50 %) | 12 |
| *F. graminearum* | 14 (30 %) | 7 |
| *F. poae* | 9 (20 %) | 7 |
| *F. langsethiae* | 4 (9 %) | 2 |
| *Microdochium nivale* | 3 (7 %) | 3 |
| *Fusarium* sp. (not identified) | 3 (7 %) | 3 |

*Levels of mycotoxins in oats and barley*

As usually observed, and reflecting the patterns of *Fusarium* species (Table 3), the levels of trichothecenes were higher in oats than in barely (Table 1). In 2017, however, the major trichothecene mycotoxin, DON, was found at low level – with mean concentration in oats about 1/3 of the corresponding concentration in 2016 (6). From 2016, the annual report on mycotoxin surveillance in feed also includes modified compounds of DON, which include acetylated compounds (3-Ac-DON and 15-Ac-DON) and a glucoside (DON-3-G). Like DON, the modified compounds were primarily present in oats. 3-Ac-DON was present at low levels in several samples, and DON-3-G in some samples at more significant levels. 15-Ac-DON was not detected, as usual, in Norwegian samples (6). DON and the metabolites were significantly correlated in both oats and barley (Figure 1 and 2) and contribute substantially to the total DON concentration. No samples exceeded the recommended limit for DON in feed material by EU and Norway (8000 µg/kg) (4, 7). DON was not significantly correlated with total *Fusarium* in oats nor in barley (data not shown).

T-2 and HT-2 for which recommendations exist as the sum of T-2 + HT-2 in EU and Norway (4, 8) were also primarily found in oats and at a similar level as in 2016 (6). The level of T-2 and HT-2 may be considered as moderate (Table 1).

Nivalenol was hardly detected in oats and barley as usual.

ZEN was detected in a few cereal samples at levels that were far below the recommended limit in feed materials (2000 µg/kg) in EU and Norway (4, 7).

Ergot alkaloids were sporadically detected in the barley samples but hardly in the oat samples (Table 4), similarly as in 2016 (6). Considering that data on toxic effects for risk assessment are lacking, the occurrence of these compounds in cereal feed materials should be taken into consideration. Dose-response studies using ergot alkaloids have not shown major quantitative difference in toxicity between the compounds in rats, with no-observed-adverse- effect- levels (NOAELs) of sum ergot alkaloids in the region 0.22-0.60 mg/kg b.w. per day (2). This corresponds to 3-7 mg/kg dry matter feed. Few dose-response studies have been conducted in livestock animals. Reduced feed intake was shown in piglets fed total alkaloids in the range 3.6-11 mg/kg dried feed. In chicken, intestinal inflammation was induced when fed 2.8 mg/kg dried feed and above (2). The highest levels of ergot alkaloids detected in the barley may be of concern for livestock animals if using this barley as a major feed ingredient.

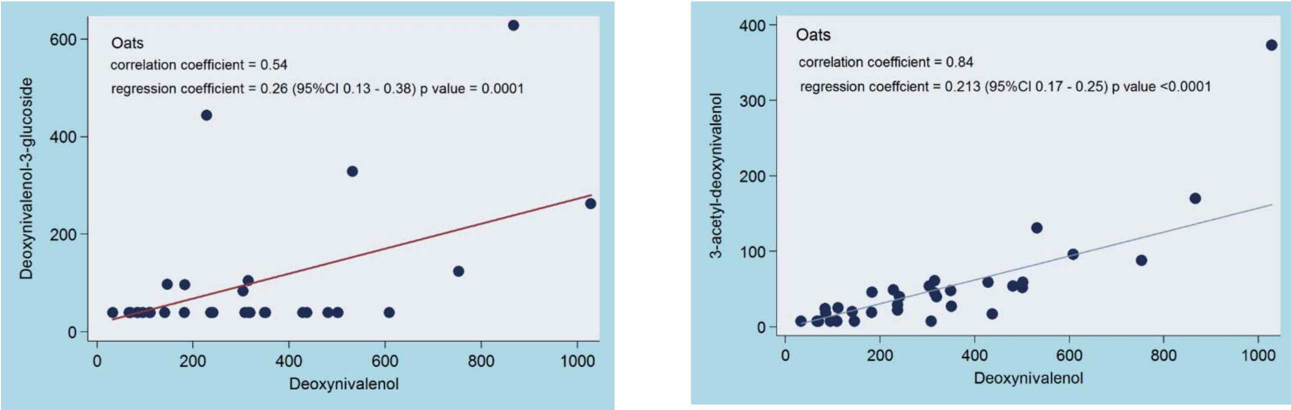


**Figure 1**. Correlation between DON and DON-3-glucoside (left) and DON and 3-acetyl-DON (right) in oats (N=46). A regression line is fitted to the points and that allows predictions of levels of metabolites given the level of DON detected and vice versa.

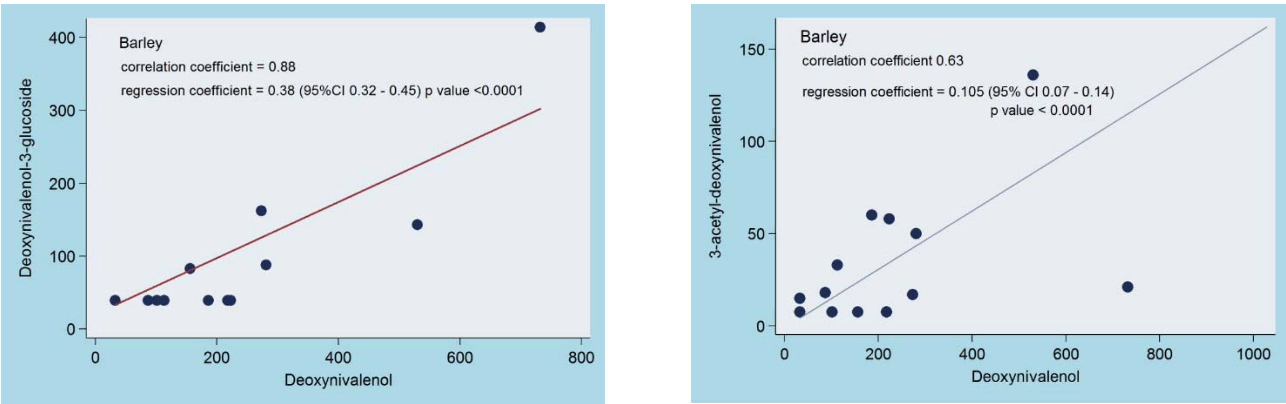


**Figure 2**. Correlation between DON and DON-3-glucoside (left) and DON and 3-acetyl-DON (right) in barley (N=46). A regression line is fitted to the points and that allows predictions of levels of metabolites given the level of DON detected and vice versa.

**Table 4.** Concentrations (µg/kg) of ergot alkaloids (ergonovine, ergosine, ergotamine, ergocornine, alpha-ergocryptine, ergocristine and sum ergot alkaloids in oats and barley sampled in Norway in 2017.

| | Ergo-novine | Ergo-sine | Ergot-amine | Ergo-cornine | α-Ergo-cryptine | Ergo-cristine | Σ Ergot alkaloids |
|---|---|---|---|---|---|---|---|
| Oats (n = 46) | | | | | | | |
| Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| Median | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| Min / max | <56 | <12 | <40 | <12 / 16 | <190 | <24 | <330 |
| St. deviation | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| % samples above detection limit | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Barley (n = 46) | | | | | | | |
| Mean | <56 | 28 | <40 | <12 | <190 | 40 | <330 |
| Median | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| Min-max | <56 | <12 / 1 040 | <40 | <12 | <190 | <24 / 1 290 | <330/ 2 480 |
| St. deviation | 0 | 150 | 0 | 0 | 0 | 190 | 340 |
| % samples above detection limit | 0 | 2 | 0 | 0 | 0 | 2 | 2 |

*Temporal and regional differences of fungi and mycotoxins in cereals*

While the level of total mould was similar as in 2016, it was far below the high level measured in oats in 2014 (mean concentration 1,940,000 cfu/g) (6, 9). Regarding total *Fusarium,* the level in 2017 was reduced compared with 2016 and also lower than most years of measurement during the last decade (6, 9). Storage mould was similar in 2017 and 2016, but comparison with previous years was not possible due to lack of data. Yeast was not measured previous years.

The concentrations of DON and T-2 + HT-2 in oats have been determined yearly in corresponding surveillance programs since 2002 and the mean DON concentration determined in 2017 was at the lower end of the scale (Figure 3). In fact, the DON concentrations have been relatively low during the last years since the peak DON level found in oats in 2012. The mean concentration of T-2+HT-2 in 2017 was at an average level (Figure 3).

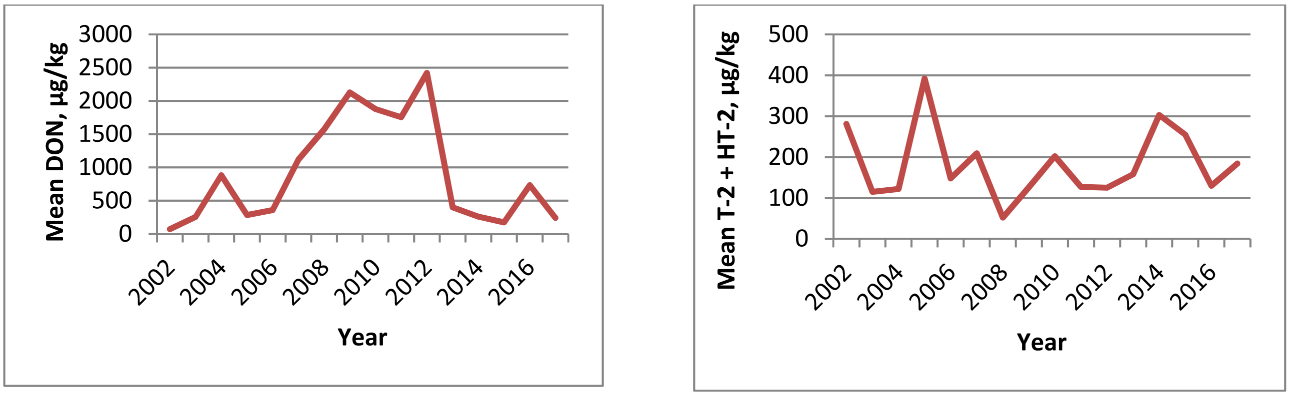


**Figure 3**. Mean concentration of deoxynivalenol (DON) (left) and the sum of T-2 toxin and HT-2 toxin (right) in 30-60 samples of oats per year in the Norwegian surveillance programme for feed.

With respect to regional differences in oats and barley, the levels of total mould and yeast in oats and barley were significantly higher in region Stor-Oslo than in the other regions, and total *Fusarium* was significantly higher in oats from Stor-Oslo than from region Midt (Table 5).

Regarding mycotoxins, the only significant regional difference was significantly lower levels of T-2+ HT-2 in oats from region Midt (Trøndelag, Møre og Romsdal) compared with Stor-Oslo (Tables 5 and 6). Detection of T-2 and HT-2 in Trøndelag, although at a lower level than in south-eastern Norway, was a new finding. In previous surveys no T-2 and HT-2 have been found in Trøndelag [6, 10]. These differences between Trøndelag and south eastern regions of Norway is most probably due to a normally colder climate for production of these mycotoxins in Trøndelag. The responsible fungi, *F. langsethiae,* is previously documented in Trøndelag at a similar level as further south [10]. Several studies indicate that T-2 and HT-2 are produced at relatively warm and dry climate [11,12]. In 2017, these toxins were produced in oats from Trøndelag which showed a particularly warm growing season [13]. With warmer summers in Trøndelag, more similar to the climate in southern Norway, this regional difference on T-2 and HT-2 will probably disappear over the next few years.

**Table 5.** Survey between regions Øst (counties Buskerud, Vestfold, Telemark, Hedmark, Oppland), Stor-Oslo (Akershus, Oslo, Østfold) and Midt (Nord-Trøndelag, Sør-Trøndelag and Møre og Romsdal) on fungi (total mould, *Fusarium* spp., storage fungi and yeast (cfu/g) and trichothecenes (deoxynivalenol (DON), 3-acetyl-DON, 15-acetyl-DON, DON-3-glucoside, sum of T-2 and HT-2 toxin, nivalenol) and zearalenone (all toxin concentrations µg/kg) in oats and barley sampled in Norway in 2017. Different superscript letters for a parameter in the same cereal species indicate significant differences between regions (p<0.05).

| | | Total mould | Total *Fusarium* | Storage fungi | Yeast | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2+ HT-2 | NIV | ZEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oats** | | | | | | | | | | | | |
| **Øst** n=15 | Mean | 602 000[b] | 21 600[ab] | 30 800 | 355 000[ab] | 314 | 46 | <52 | 125 | 157[ab] | 37 | 19 |
| | St. dev. | 712 000 | 24 200 | 70 100 | 583 000 | 242 | 50 | 0 | 186 | 146 | 73 | 38 |
| **Stor-O** n=21 | Mean | 843 000[a] | 27 000[a] | 800 | 729 000[a] | 195 | 38 | <52 | <80 | 250[a] | <30 | <10 |
| | St. dev. | 734 000 | 24 500 | 3 300 | 828 000 | 238 | 79 | 0 | 51 | 163 | 23 | 0 |
| **Midt** n=10 | Mean | 88 000[b] | 8 400[b] | 20 400 | 192 000[b] | 228 | 34 | <52 | <80 | 84[b] | <30 | <10 |
| | St. dev. | 77 000 | 9 400 | 63 100 | 122 000 | 242 | 30 | 0 | 33 | 90 | 0 | 0 |
| **Barley** | | | | | | | | | | | | |
| **Øst** n=16 | Mean | 148 000[b] | 16 600 | 2 300 | 293 000[b] | 119 | <16 | <52 | <80 | <36 | <30 | 10 |
| | St. dev. | 192 000 | 24 700 | 5 000 | 336 000 | 180 | 16 | 0 | 93 | 12 | 0 | 18 |
| **Stor-O** n=19 | Mean | 179 000[a] | 11 100 | 4 800 | 630 000[a] | 90 | 19 | <52 | <80 | <36 | <30 | <10 |
| | St. dev. | 131 000 | 12 800 | 10 000 | 493 000 | 123 | 31 | 0 | 24 | 49 | 4 | 2 |
| **Midt** n=10 | Mean | 62 000[b] | 10 300 | 200 | 234 000[b] | <66 | <16 | <52 | <80 | <36 | <30 | <10 |
| | St. dev. | 60 000 | 9 700 | 300 | 139 000 | 0 | 0 | 0 | 0 | 42 | 0 | 0 |

**Table 6.** Regional survey of the concentrations of ergotalkaloids (ergonovine, ergosine, ergotamine, ergocornine, alpha-ergocryptine, ergocristine and sum ergot alkaloids in oats and barley sampled in Norway in 2017.

| | | Ergo-novine | Ergo-sine | Ergo-tamine | Ergo-cornine | α-Ergo-cryptine | Ergo-cristine | Σ Ergot alkaloids |
|---|---|---|---|---|---|---|---|---|
| **Oats** | | | | | | | | |
| **Øst** n=15 | Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| | St. dev. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Stor-O** n=21 | Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| | St. dev. | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| **Midt** n=10 | Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| | St. dev. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Barley** | | | | | | | | |
| **Øst** n=16 | Mean | <56 | 67 | <40 | <12 | <190 | 87 | <330 |
| | St. dev. | 0 | 250 | 0 | 0 | 0 | 310 | 560 |
| **Stor-O** n=19 | Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| | St. dev. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Midt** n=10 | Mean | <56 | <12 | <40 | <12 | <190 | <24 | <330 |
| | St. dev. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Thus, the weather during the growing season is a key factor for the *Fusarium* and mycotoxin contents of the cereal grain. Of particular importance is the level of precipitation and humidity during flowering (usually in July), as well as temperature and precipitation up to harvest in autumn (1). The low *Fusarium* and DON level in 2017 may be attributed to the relatively low precipitation in July in south-eastern Norway (regions Stor-Oslo and Øst) and moderate precipitation in Trøndelag (region Midt), combined with warm September with moderate and low precipitation in south-eastern regions and Trøndelag, respectively (13).

Figure 3 illustrates a kind of inverse relationship between DON and HT-2 + T-2 in oats during 2002-2017. Thus, in "good" years when DON contamination is low, there may be a reason to expect increased problems with T-2/HT-2 contamination. Therefore, a one-sided focus on eradication of *F. graminearum* may result in proliferation and increased problems with *F. langsethiae*. This situation is supported by the observation that currently, no fungicides have demonstrated effect against *F. langsethiae* in the field (14).

*Aflatoxins in maize*
In one of ten analysed maize samples, aflatoxin B1 and B2 were detectable at 9.1 and 0.7 µg/kg, respectively. No samples were above the maximum limit (20 µg/kg).

## Complete and complementary feed

*Feed for ruminants*
The main purpose of the analysis of aflatoxins in feed for ruminants is to monitor and control the risk of aflatoxin metabolites in milk and dairy products for human consumption. In the current study, none of the 50 samples of complementary compound feed for ruminants contained detectable levels. This is a satisfactory result and also in accordance with most previous results on these carcinogenic toxins (1, 6, 9).

*Feed for pig*
The levels of analysed mycotoxins in complete compound feed for pigs are shown in Table 7. DON was detected in most samples, but all samples were below the recommended limit for feed for pig in Norway (500 µg/kg) (4). The co-occurrence of the DON-related compounds, 3- and 15-Ac-DON and DON-3-G was documented in the present surveillance programme. Although their concentrations in general were lower than that of DON, their relative concentrations were considerable. The concentrations of the metabolites 3-Ac-DON and DON-3-G were significantly correlated with the DON level (r=0.789 and r=0.690, respectively), but 15-Ac-DON was not correlated with DON (r=0.044). The DON-related compounds may be an additional factor to the total DON exposure and EFSA consider their toxic effects like that of DON (15). NIV was hardly present. The sum of T-2 and HT-2 was present in 40 % of the pig feed samples, but not above the recommended limit (250 µg/kg) (4, 8). The levels of DON and T-2/HT-2 were similar as in 2016.

ZEN was below the recommended level for pig feed in Norway (250 µg/kg) in all samples (4), similarly as the findings in 2016. Unfortunately, the samples were not analysed for ZEN metabolites, which potentially may contribute to an estrogenic effect of these compounds. In 2016 the metabolite alpha-zearalenol, which holds higher estrogenic activity than ZEN was found at significant concentrations in one sample of pig feed (6). However, no official regulations exist for ZEN metabolites.

**Table 7**. Complete compound feed for pigs 2017. Concentrations of deoxynivalenol (DON), 3-acetyl-DON, 15-acetyl-DON, DON-3-glucoside, sum of T-2 and HT-2 toxin, nivalenol, zearalenone and sum of ergot alkaloids (µg/kg).

| | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2+HT-2 | NIV | ZEN | Σ Ergot alkaloids |
|---|---|---|---|---|---|---|---|---|
| Number | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Mean | 125 | <16 | <52 | <80 | 49 | <30 | 14 | <330 |
| Median | 122 | <16 | <52 | <80 | <36 | <30 | <10 | <330 |
| Min / max | <66 / 355 | <16 / 58 | <52 / 144 | <80 / 160 | <36 / 142 | <30 / 43 | <10 / 68 | <330 / 1 620 |
| St. deviation | 78 | 15 | 38 | 27 | 42 | 6 | 20 | 320 |
| % samples above detection limit | 80 | 20 | 30 | 5 | 40 | 5 | 30 | 5 |
| % samples above guidance values | 0 | | | | 0 | | 0 | |

OTA was not detected in the samples of feed for pig. However, the level of detection was relatively high (21 µg/kg) compared with the recommended level for pig feed in Norway (10 µg/kg) (4). Previous years, with lower detection levels, OTA was commonly found in trace concentrations in most samples, but very seldom above recommended level.

Ergot alkaloids were detected in a single sample which contained ergosine and ergocornine at sum concentration 1620 µg/kg. The sum of ergot alkaloids is considered to be of concern but toxicological data are very limited.

*Feed for dog*

DON and ZEN were detected in several samples, but at insignificant levels below recommended levels for dog feed in Norway (DON: 2000 µg/kg, ZEN: 500 µg/kg) (4). EU has recently established recommended levels for ZEN in feed for dogs (200 µg/kg for adults and 100 µg/kg for puppies and bitches for reproduction) (7) and all sample results were below these levels. T-2 and HT-2 were only detected in a single sample close to, but below recommended level (T-2+HT-2: 250 µg/kg) (4, 8).

OTA was not detected in the samples of feed for dog. However, the level of detection was relatively high (21 µg/kg). In 2016, with lower detection level of the analytical method, OTA was found in trace concentrations in all samples. The recommended limit of OTA in feed for dog in Norway is 1000 µg/kg (4). However, EU has recently established recommended limit for OTA in feed for dogs (10 µg/kg) (7) and we do not know if OTA were present between EU-recommended limit and our detection limit.

Ergot alkaloids were detected in a single sample which contained ergosine, ergotamine, ergocornine, α-ergocryptine and ergocristine at sum concentration 2250 µg/kg. The sum of ergot alkaloids is considered to be of concern but toxicological data are very limited.

**Table 8**. Complete compound feed for dogs 2017. Concentrations of deoxynivalenol (DON), sum of T-2 and HT-2 toxin, nivalenol, zearalenone and sum of ergot alkaloids (µg/kg).

| | DON | T-2+HT-2 | NIV | ZEN | Σ Ergot alkaloids |
|---|---|---|---|---|---|
| Number | 25 | 25 | 25 | 25 | 25 |
| Mean | 95 | <36 | <30 | 12 | <330 |
| Median | <66 | <36 | <30 | <10 | <330 |
| Min / max | <66 / 641 | <36 / 236 | <30 / 43 | <10 / 61 | <330 / 2250 |
| St. deviation | 141 | 44 | 8 | 15 | 420 |
| % samples above detection limit | 28 | 4 | 8 | 28 | 4 |
| % samples above guidance values | 0 | 0 | | 0 | |

# Conclusions

## Feed ingredients

- Fungi in oats and barley: In oats, 30% of the samples had higher concentrations than the guidance values of total mould, and 7% of the oat samples had also higher concentrations than the guidance values of storage mould. Barley had significantly less total mould and storage mould than oats but similar *Fusarium* and yeast levels as oats. The levels of total mould were significantly correlated with *Fusarium* and yeast.
- Trichothecenes in oats and barley: Oats had higher levels of trichothecene mycotoxins than barely. DON and T-2 and HT-2 were the major toxins detected. Compared with previous years, DON was found at relatively low level and T-2+HT-2 at moderate level in 2017. The low DON level in 2017 may be related to the relatively low precipitation in July combined with warm and relatively dry September. DON-related compounds (acetyl-DON and DON-glucoside) were found at lower levels than DON, but

constituted a considerable contribution to total DON-compounds in several samples and were significantly correlated with DON. Concerning regional considerations, the occurrence of T-2 and HT-2 in oats from Region Midt (Trøndelag, Møre and Romsdal) is reported for the first time, at levels which are still lower than in oats from south-eastern Norway. The reason for their occurrence is probably a particularly warm growing season in Trøndelag in 2017.

- Zearalenone in oats and barley was only detected in a few cereal samples and far below the recommended limit in feed materials.
- Ergot alkaloids in oats and barley were found sporadically in barley, but hardly detected in oats. The highest levels of ergot alkaloids detected in the barley may be of concern for livestock animals if using this barley as a major feed ingredient.
- Aflatoxins in maize were not found above the maximum limit.

### Feed

- Complementary compound feed for ruminants: No aflatoxins were detected.
- Compound feed for pig: DON was detected in most samples, but all samples were below the recommended level for feed for pig in Norway. All DON-related compounds, 3- and 15-Ac-DON and DON-3-G were detected in some samples, all at lower concentrations that DON, but at considerable relative concentrations. T-2 + HT-2 was present in 40 % of the pig feed samples but not above the recommended level. ZEN was below the recommended level in feed for pig in Norway. OTA was not detected in any sample of feed for pig, however, the level of detection was relatively high. The sum of ergot alkaloids in a single sample is considered to be of concern but toxicological data are very limited.
- Compound feed for dog: DON and ZEN were detected in several samples at insignificant levels below recommended levels for dog feed in Norway and EU. T-2 and HT-2 were only detected in a single sample close to, but below recommended level. OTA was not detected in any sample of feed for dog, however, the level of detection was relatively high. The sum of ergot alkaloids in a single sample is considered to be of concern but toxicological data are very limited.

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# Appendix

**Appendix Table 1**. Concentrations of fungi (total mould, *Fusarium*, storage fungi, yeast) and mycotoxins in **oats** (46 samples) and **barley** (46 samples) in individual samples from different districts and regions 2017. Concentration of fungi in cfu/g. Concentrations of mycotoxins in µg/kg. DON=deoxynivalenol, 3-Ac-DON=3-acetyl-DON, 15-Ac-DON=15-acetyl-DON, DON-3-G=DON-3-glucoside, T-2=T-2 toxin, HT-2=HT-2 toxin, NIV=nivalenol, ZEN=zearalenone. The most dominant species of *Fusarium* in each sample is marked as follow: $^{Fa}$ = *F. avenaceum*, $^{Fp}$ = *F. poae*, $^{Fg}$ = *F. graminearum*, $^{Ft}$ = *F. tricinctum*, $^{Fl}$ = *F. langsethiae*, $^{Mn}$ = *Microdocchium nivale*, $^{Ms}$ = *M. seminicola*.

| Jnr. | Mould | *Fusarium* | Storage fungi | Yeast | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2 | HT-2 | NIV | ZEN | Ergo-novine | Ergo-sine | Ergot-amine | Ergo-cornine | α-Ergo-cryptine | Ergo-cristine |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OATS Region Midt** | | | | | | | | | | | | | | | | | | |
| 2017-23-224-3 | 21000 | 150$^{Fa}$ | <50 | 59000 | <66 | <16 | <52 | <80 | 79 | 171 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-224-4 | 73000 | 2500$^{Fp}$ | <50 | 250000 | <66 | <16 | <52 | <80 | 111 | 128 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-231-2 | 170000 | 5000$^{Fa}$ | <50 | 410000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-232-1 | 25000 | 2500$^{Fg}$ | <50 | 140000 | 315 | 45 | <52 | 105 | <14 | 57 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-232-3 | 170000 | 25000$^{Fa}$ | 3000 | 190000 | 428 | 59 | <52 | <80 | 28 | 95 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-233-1 | 55000 | 10000$^{Fg}$ | <50 | 30000 | 753 | 88 | <52 | 124 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-237-1 | 240000 | <50 | 200000 | 190000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-237-2 | 55000 | 10000$^{Fg}$ | <50 | 370000 | 304 | 54 | <52 | 84 | <14 | 30 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-243-1 | 36000 | 25000$^{Ft}$ | 500 | 130000 | 315 | 61 | <52 | <80 | <14 | 57 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-287-1 | 30000 | 3500$^{Fa}$ | <50 | 150000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| **BARLEY Region Midt** | | | | | | | | | | | | | | | | | | |
| 2017-23-224-1 | 50000 | 25000$^{Ft}$ | <50 | 350000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-224-2 | 45000 | 5000$^{Ft}$ | <50 | 430000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-225-1 | 36000 | 27000$^{Mn}$ | <50 | 77000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-226-1 | 16000 | 6400$^{Fp}$ | <50 | 150000 | <66 | <16 | <52 | <80 | 65 | 87 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-231-1 | 15000 | 100 | 800 | 86000 | <66 | <16 | <52 | <80 | <14 | 24 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-232-2 | 41000 | 15000$^{Mn}$ | 100 | 440000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-232-4 | 41000 | 5000$^{Mn}$ | 650 | 140000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-237-3 | 210000 | 15000$^{Ft}$ | <50 | 160000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-237-4 | 120000 | 2500$^{Fa}$ | 100 | 330000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-287-2 | 45000 | 1500$^{Fa}$ | <50 | 180000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| **OATS Region Stor-Oslo** | | | | | | | | | | | | | | | | | | |
| 2017-21-87-1 | 360000 | 1500 | <50 | 1000000 | <66 | <16 | <52 | <80 | 95 | 218 | 47 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-21-89-1 | 360000 | 10000[Fl] | <50 | 200000 | 111 | 25 | <52 | <80 | 43 | 138 | 56 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-91-1 | 800000 | 100000[Fg] | <50 | 1400000 | 141 | 20 | <52 | <80 | 63 | 126 | <30 | <10 | <53 | <12 | <40 | 16 | <190 | <24 |
| 2017-23-197-1 | 730000 | 50000[Fp] | <50 | 680000 | <66 | <16 | <52 | <80 | 58 | <22 | 111 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-198-2 | 2400000 | 50000[Ft] | <50 | 2300000 | <66 | <16 | <52 | <80 | 129 | 326 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-199-2 | 440000 | 5000[Ft] | <50 | 1100000 | 67 | <16 | <52 | <80 | 173 | 213 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-210-2 | 1500000 | 5000[Ft] | <50 | 700000 | <66 | <16 | <52 | <80 | 160 | 433 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-211-1 | 860000 | 25000[Fg] | <50 | 820000 | <66 | <16 | <52 | <80 | 118 | 234 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-214-1 | 910000 | 50000[Fp] | <50 | 150000 | 349 | 48 | <52 | <80 | <14 | 184 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-221-2 | 3000000 | 40000[Fg] | 500 | 3300000 | 481 | 54 | <52 | <80 | 54 | 357 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-222-2 | 1000000 | 50000[Fl] | <50 | 1400000 | 85 | 18 | <52 | <80 | <14 | 161 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-260-2 | 500000 | 10000[Fl] | <50 | 590000 | 182 | 19 | <52 | <80 | 62 | 421 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-261-2 | 370000 | 25000[Fp] | <50 | 410000 | 502 | 59 | <52 | <80 | 61 | 119 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-262-2 | 450000 | 15000[Fp] | <50 | 110000 | 237 | 29 | <52 | <80 | 149 | 231 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-263-2 | 350000 | 18000[Fp] | <50 | 110000 | 183 | 46 | <52 | 97 | 123 | 192 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-266-2 | 1600000 | 50000[Fl] | <50 | 450000 | 237 | 22 | <52 | <80 | 68 | 201 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-267-2 | 460000 | 20000[Fl] | <50 | 150000 | 109 | <16 | <52 | <80 | 44 | 92 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-288-2 | 180000 | 18000[Fl] | <50 | 65000 | 1028 | 373 | <52 | 263 | <14 | 38 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-289-2 | 330000 | 4500[Fg] | 15000 | 41000 | 146 | <16 | <52 | 98 | <14 | 33 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-290-2 | 200000 | <50 | 650 | 5000 | <66 | <16 | <52 | <80 | <14 | 24 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-291-2 | 910000 | 20000[Fp] | <50 | 320000 | <66 | <16 | <52 | <80 | <14 | 67 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| **BARLEY Region Stor-Oslo** | | | | | | | | | | | | | | | | | | |
| 2017-21-85-1 | 350000 | 5000[Fg] | <50 | 1900000 | <66 | <16 | <52 | <80 | 87 | 140 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-86-1 | 290000 | 14000[Ft] | <50 | 1100000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-88-1 | 160000 | 15000[Fp] | <50 | 1400000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-198-1 | 140000 | 5000[Ft] | <50 | 820000 | <66 | <16 | <52 | <80 | 19 | 29 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-199-1 | 110000 | 6000[Fg] | 5500 | 650000 | <66 | <16 | <52 | <80 | <14 | 33 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-210-1 | 120000 | 5000[Fg] | <50 | 1000000 | <66 | <16 | <52 | <80 | <14 | <22 | 32 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-214-2 | 110000 | 2000[Fg] | <50 | 260000 | 87 | 18 | <52 | <80 | 18 | 61 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-221-1 | 350000 | 50000[Fp] | 650 | 820000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-222-1 | 490000 | 14000[Fp] | <50 | 590000 | 113 | 33 | <52 | <80 | <14 | <22 | <30 | 10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-260-1 | 50000 | 1500 | <50 | 590000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-261-1 | 210000 | 30000[Fa] | <50 | 280000 | 223 | 58 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-23-262-1 | 150000 | 5000[Ft] | 41000 | 450000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-263-1 | 140000 | 20000[Fa] | 5000 | 55000 | 101 | <16 | <52 | <80 | <14 | <22 | <30 | 11 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-266-1 | 280000 | 4500[Fg] | 10000 | 190000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-267-1 | 290000 | 27000[Fp] | <50 | 680000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-288-1 | 91000 | 1500[Fa] | 15000 | 860000 | 530 | 136 | <52 | 143 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-289-1 | 34000 | 3000[Ft] | 14000 | 50000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-290-1 | 2000 | 550 | <50 | 17000 | 218 | <16 | <52 | <80 | <14 | 25 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-291-1 | 30000 | 2500[Fp] | <50 | 250000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| **OATS Region Øst** | | | | | | | | | | | | | | | | | | |
| 2017-23-195-2 | 130000 | 18000[Fl] | <50 | <50 | 84 | 24 | <52 | <80 | 53 | 96 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-218-1 | 140000 | 10000[Fp] | 400 | 120000 | 501 | 52 | <52 | <80 | 76 | 366 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-219-3 | 440000 | 10000[Fg] | <50 | 130000 | 319 | 40 | <52 | <80 | 41 | 96 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-236-2 | 2100000 | 90000[Fa] | <50 | 910000 | 228 | 49 | <52 | 444 | 81 | 166 | 298 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-239-1 | 2100000 | 50000[Fl] | 27000 | 410000 | 532 | 131 | <52 | 329 | 76 | 205 | 60 | 136 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-246-1 | 1600000 | 5000[Ms] | 5000 | 820000 | 608 | 96 | <52 | <80 | 97 | 177 | <30 | 85 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-253-2 | 480000 | 50000[Fp] | <50 | 110000 | 308 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-269-1 | 220000 | 5000[Fl] | 10000 | 36000 | 241 | 40 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-270-1 | 130000 | 20000[Fg] | <50 | 2200000 | 95 | <16 | <52 | <80 | 142 | 283 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-271-1 | 350000 | 10000[Ft] | 230000 | 82000 | 70 | <16 | <52 | <80 | 28 | 111 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-272-1 | 180000 | 5000[Fa] | <50 | 22000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-273-1 | 230000 | 18000[Fl] | <50 | 100000 | 867 | 170 | <52 | 628 | 26 | 72 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-274-1 | 220000 | 3000[Fg] | 170000 | 40000 | 437 | 17 | <52 | <80 | <14 | 68 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-275-1 | 120000 | 5000[Fl] | 20000 | 90000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-276-1 | 590000 | 25000[Fg] | <50 | 250000 | 351 | 27 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| **BARLEY Region Øst** | | | | | | | | | | | | | | | | | | |
| 2017-23-195-1 | 120000 | 5000[Ft] | <50 | 950000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-212-1 | 75000 | 10000[Fl] | <50 | 400000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-213-1 | 91000 | 5500[Fg] | <50 | 160000 | 281 | 50 | <52 | 88 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-218-2 | 100000 | 5000[Fa] | <50 | 180000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-219-1 | 77000 | 2500[Fa] | 500 | 520000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | 1040 | <40 | <12 | <190 | 1288 |
| 2017-23-219-2 | 77000 | 1500[Fa] | <50 | 550000 | <66 | <16 | <52 | <80 | <14 | 29 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-236-1 | 860000 | 100000[Fp] | <50 | 1200000 | 186 | 60 | <52 | <80 | <14 | 57 | <30 | 79 | <53 | <12 | <40 | <12 | <190 | <24 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-23-239-2 | 200000 | 18000[Fa] | 15000 | 140000 | 732 | 21 | <52 | 414 | <14 | <22 | <30 | 26 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-253-1 | 200000 | 10000[Ft] | <50 | 110000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-269-2 | 20000 | 3500[Ft] | 150 | 24000 | 156 | <16 | <52 | 83 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-270-2 | 200000 | 50000[Fa] | <50 | 86000 | 273 | 17 | <52 | 162 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-271-2 | 26000 | 5900[Ft] | 12000 | 40000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-272-2 | 150000 | 6500[Ft] | 550 | 100000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-273-2 | 68000 | 4500[Fl] | <50 | 210000 | <66 | 15 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-274-2 | 130000 | 9500[Fa] | <50 | 100000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-275-2 | 60000 | 15000[Fg] | <50 | 55000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |
| 2017-23-276-2 | 54000 | 30000[Fa] | 11000 | 160000 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <53 | <12 | <40 | <12 | <190 | <24 |

**Appendix Table 2.** Concentrations of mycotoxins in individual samples of **complete feed for pigs** (20 samples) 2017. All concentrations in µg/kg. DON=deoxynivalenol, 3-Ac-DON=3-acetyl-DON, 15-Ac-DON=15-acetyl-DON, DON-3-G=DON-3-glucoside, T-2=T-2 toxin, HT-2=HT-2 toxin, NIV=nivalenol, ZEN=zearalenone.

| Jnr. | Type of feed | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2 | HT-2 | NIV | ZEN | Ergo-novine | Ergo-sine | Ergot -amine | Ergo-cornine | α-Ergo-cryptin | Ergo-cristine |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-21-13-1 | Format Vekst 120 | 236 | 55 | <52 | <80 | 38 | 99 | <30 | 14 | <56 | 1090 | <40 | 375 | <190 | <24 |
| 2017-21-139-1 | Format Kvikk 140 | 100 | <16 | <52 | <80 | <14 | 24 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-14-1 | Fiskå Opti Norm | 118 | <16 | <52 | <80 | <14 | <22 | 43 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-171-1 | Format Vekst 110 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | 31 | <40 | <12 | <190 | 37 |
| 2017-21-174-1 | Formel Vekst 120 | <66 | <16 | 90 | <80 | 22 | 52 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-174-2 | Format Purke | 131 | <16 | <52 | <80 | 38 | 68 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-179-1 | Format Purke | 70 | <16 | <52 | <80 | <14 | <22 | <30 | 12 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-18-1 | Format Vekst 110 | 355 | 58 | <52 | 160 | <14 | 22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-180-1 | Format Purke | 148 | 21 | <52 | <80 | 23 | 55 | <30 | 12 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-180-2 | Format Kvikk 160 | <66 | <16 | <52 | <80 | <14 | <22 | <30 | 68 | <56 | 29 | <40 | 36 | <190 | <24 |
| 2017-21-22-1 | Format Purke | 173 | 24 | 92 | <80 | 14 | 50 | <30 | 42 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-46-1 | Fullfôr til svin | 84 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-47-1 | Fullfôr til svin | 106 | <16 | <52 | <80 | <14 | 135 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-59-1 | Fiskå Opti Appetitt | 125 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-60-1 | Fiskå Opti Vital Pluss | 184 | <16 | 144 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-60-2 | Fiskå Opti Drektig | 74 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-61-1 | Kvikk 160 | 158 | <16 | 107 | <80 | <14 | <22 | <30 | 64 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-61-2 | Format vekst 105 | 160 | <16 | 85 | <80 | <14 | 40 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-64-1 | NF Svin Drektig Solid | <66 | <16 | 96 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-98-1 | Smågris, fullfôr | 150 | <16 | <52 | <80 | <14 | 83 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |

**Appendix Table 3.** Concentrations of mycotoxins in individual samples of **complete feed for dogs** (25 samples) 2017. All concentrations in µg/kg. DON=deoxynivalenol, 3-Ac-DON=3-acetyl-DON, 15-Ac-DON=15-acetyl-DON, DON-3-G=DON-3-glucoside, T-2=T-2 toxin, HT-2=HT-2 toxin, NIV=nivalenol, ZEN=zearalenone, ergonovine, ergosine, ergotamine, ergocornine, alpha-ergocryptine, ergocristine.

| Jnr. | Type of feed | DON | 3-Ac-DON | 15-Ac-DON | DON-3-G | T-2 | HT-2 | NIV | ZEN | Ergo-novine | Ergo-sine | Ergot-amine | Ergo-cornine | α-Ergo-cryptine | Ergo-cristine |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-21-11-1 | Coop Xtra Hundefôr | 379 | <16 | <52 | <80 | <14 | <22 | <30 | 29 | <56 | 456 | 456 | 471 | 430 | 404 |
| 2017-21-124-1 | Pedigree Adult Mini | 147 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-125-1 | Coop Møre ringer | 105 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-126-1 | Max Dog Adult | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-127-1 | Frolic complete | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-128-1 | COOP Optimal Balance Adult | 201 | <16 | <52 | <80 | <14 | 229 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-138-1 | Labb Ekstrem | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-138-2 | Appetitt Adult Maintenance | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-138-3 | Labb Pluss alle raser | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-140-1 | Acana Puppy & Junior | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-156-1 | Eukanuba Adult, med. breed | 88 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-157-1 | Purina One, Small dog active | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-158-1 | Royal Canine mini adult | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-160-1 | Labb Voksen | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-161-1 | Royal Canine Junior | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-165-1 | Royal Canine Adult XS-small | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-165-2 | Labb Honnør | <66 | <16 | <52 | <80 | <14 | <22 | <30 | 11 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-166-1 | Eldorado Adult Dogs | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-3-1 | Royal Canine Adult | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-4-1 | xx Lamb & Rice Adult 1+ | <66 | <16 | <52 | <80 | <14 | <22 | <30 | 40 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-5-1 | Royal Canine Professional Sens. | <66 | <16 | <52 | <80 | <14 | <22 | <30 | 11 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-53-1 | Nordic Delight kattefoder | <66 | <16 | <52 | <80 | <14 | <22 | <30 | 61 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-6-1 | Maxdog Adult | 208 | <16 | <52 | <80 | <14 | <22 | 43 | 30 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-7-1 | First Price Tørrfôr | 641 | <16 | <52 | <80 | <14 | <22 | 43 | 31 | <56 | <12 | <40 | <12 | <190 | <24 |
| 2017-21-9-1 | AM Nutrition | <66 | <16 | <52 | <80 | <14 | <22 | <30 | <10 | <56 | <12 | <40 | <12 | <190 | <24 |

**Appendix Table 4.** Concentrations of aflatoxin B1, B2, G1 and G2 in individual samples of **complementary feed for ruminants** (50 samples) 2017. All concentrations in µg/kg.

| Jnr. | Type of feed | Afla B1 | Afla B2 | Afla G1 | Afla G2 |
|---|---|---|---|---|---|
| 2017-21-12-1 | Formel Elite 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-16-1 | Drøv Energirik | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-17-1 | Fiskå Melketopp Nøytral | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-24-1 | Tilskuddsfôr | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-30-1 | Formel kalv | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-30-2 | Formel elite 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-30-3 | Formel sau ekstra | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-31-1 | Drøv kjøtt med gjær | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-39-1 | Tilskuddsfôr | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-40-1 | Tilskuddsfôr | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-41-1 | Formel Energi Premium 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-41-2 | Formel biff | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-42-1 | Drøv Tidligslått | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-42-2 | Alka Supervom Mjølk | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-44-1 | Tilskuddsfôr | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-45-1 | Tilskuddsfôr | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-52-1 | Natura Drøv 19 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-55-1 | Drøv Energirik m/ gjær | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-60-3 | Fiskå Nor500 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-60-4 | Fiskå Sau/lam | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-62-1 | Formel Energi | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-63-1 | Drøv Energi | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-66-1 | Fiskå Nor500 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-67-1 | Fiskå Melketopp Høg | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-68-1 | Fiskå Toplac Nøytral | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-96-1 | Drøv Moderat | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-97-1 | Formel Elite 90 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-101-1 | Drøv Energi | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-102-1 | Drøv Lam | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-111-1 | Natura Drøv | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-135-1 | Formel Biff Elite | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-135-2 | Formel Biff Intensiv | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-136-1 | Formel Biff 1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-136-2 | Formel Energi Premium | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-137-1 | Drøv Lam | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-142-1 | Formel Geit 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-142-2 | Formel Sau | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-142-3 | Reinfôr BAS | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-143-1 | Formel Energi Premium 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-143-2 | Formel Biff | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-169-1 | Formel Elite | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-170-1 | Drøv Moderat | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-172-1 | Drøv Energirik Låg | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-173-1 | Formel Biff | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-173-2 | Formel Sau Intensiv | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-173-3 | Formel Elite 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-173-4 | Formel Lam | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-173-5 | Formel Favør 80 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-178-1 | Formel Biff Kompakt | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-178-2 | Formel Energi Premium | <0.25 | <0.10 | <0.20 | <0.15 |

**Appendix Table 5.** Concentrations of aflatoxin B1, B2, G1, G2 in individual samples of **maize** (10 samples) in 2017. All concentrations in µg/kg.

| Jnr. | Afla B1 | Afla B2 | Afla G1 | Afla G2 |
|---|---|---|---|---|
| 2017-21-8-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-10-1 | 9,10 | 0,70 | <0.20 | <0.15 |
| 2017-21-19-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-27-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-29-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-75-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-83-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-112-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-141-1 | <0.25 | <0.10 | <0.20 | <0.15 |
| 2017-21-159-1 | <0.25 | <0.10 | <0.20 | <0.15 |

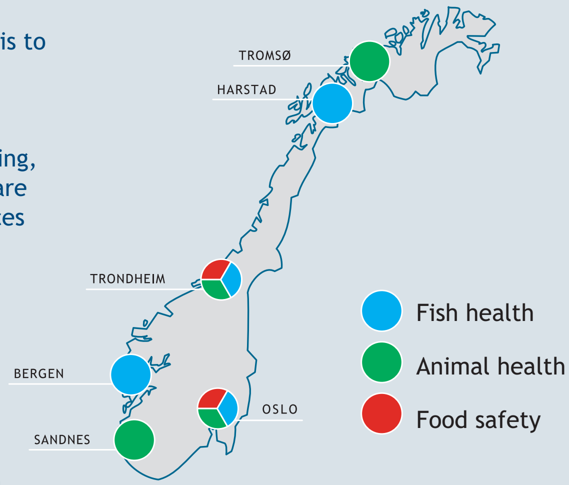
*Scientifically ambitious, forward-looking and cooperatively oriented – for integrated health*

The Norwegian Veterinary Institute is a national research institute that operates in the fields of animal and fish health, food safety and feed hygiene; its primary task is to provide the authorities with independently generated knowledge.

Emergency preparedness, diagnostic services, monitoring, reference functions, consulting, and risk assessments are all important areas of activity. Our products and services include research results and reports, analyses and diagnoses, studies and advice.

The Norwegian Veterinary Institute's central laboratory and administration lie in Oslo, and we operate regional laboratories in Sandnes, Bergen, Trondheim, Harstad and Tromsø.

The Norwegian Veterinary Institute collaborates with a large number of national and international institutions.




| Fish health | Animal health | Food safety |
| --- | --- | --- |

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