Proficiency Tests
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Evaluation Report
proficiency test

DLA 22/2017

Mycotoxins: DON and ZEA
Deoxynivalenol and Zearalenone in Cereals

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Allgemeine Informationen zur Eignungsprüfung (EP)
General Information on the proficiency test (PT)

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EP-Koordinator *PT-Coordinator*	Dr. Gerhard Wichmann
Status des EP-Bericht *Status of PT-Report*	Abschlussbericht / Final report : 9 April 2017
EP-Bericht Freigabe *PT-Report Authorization*	Dr. Matthias Besler (Technischer Leiter / Technical Manager) - *gezeichnet / signed M. Besler* Dr. Gerhard Wichmann (QM-Beauftragter / Quality Manager) - *gezeichnet / signed G. Wichmann* Datum / Date: 9 April 2017
Unteraufträge *Subcontractors*	Die Prüfung der Gehalte, Homogenität und Stabilität von EP-Parametern wird von DLA im Unterauftrag vergeben. The analysis of the content, homogeneity and stability of PT-parameters are subcontracted by DLA.
Vertraulichkeit *Confidentiality*	Die Teilnehmerergebnisse sind im EP-Bericht in anonymisierter Form mit Auswertenummern benannt. Daten einzelner Teilnehmer werden ausschließlich nach vorheriger Zustimmung des Teilnehmers an Dritte weitergegeben. Participant result are named anonymously with evalutation numbers in the PT report. Data of individual participants will be passed on to third parties only with prior consent of the participant.

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1. Introduction

The participation in proficiency testing schemes is an essential element of the quality-management-system of every laboratory testing food and feed, cosmetics and food contact materials. The implementation of proficiency tests enables the participating laboratories to prove their own analytical competence under realistic conditions. At the same time they receive valuable data regarding the verification and/or validation of the particular testing method [1, 5].
The purpose of DLA is to offer proficiency tests for selected parameters in concentrations with practical relevance.
Realisation and evaluation of the present proficiency test follows the technical requirements of DIN EN ISO/IEC 17043 (2010) and DIN ISO 13528:2009 / ISO 13528:2015 [2, 3].

2. Realisation

2.1 Test material

The test material is a mixture of different batches of corn flour (naturally contaminated with DON and ZEA) and a microtracer premix (wheat flour, microtracer iron particles (FSS red lake) for homogeneity verification.

The raw materials were sieved, combined, homogenized and then sieved again.

Approximately 4 kg of the material was packaged in about 50 grams in metallized PET film bags. The portions were numbered chronologically.

Note: *The metrological traceability of temperature, mass and volume during production of the PT samples is ensured by DAkkS calibrated reference materials.*

2.1.1 Homogeneity

The **mixture homogeneity before bottling** was examined 10-fold by **microtracer analysis.** It is a standardized method that is part of the international GMP certification system for feed [14].

Before mixing dye coated iron particles of µm size are added to the sample and the number of particles is determined after homogenization in taken aliquots. The evaluation of the mixture homogeneity is based on the Poisson distribution using the chi-square test. A probability of ≥ 5 % is equivalent to a good homogeneous mixture and of ≥ 25% to an excellent mixture [14, 15]. The microtracer analysis of the present PT sample showed probability of 81%. Additionally particle number results were converted into concentrations, statistically evaluated according to normal distribution and compared to the standard deviation according to Horwitz. This gave a HorRat value of 0,8. The results of microtracer analysis are given in the documentation.

The calculation of the **variation coefficient** of the repeatability standard deviation (CV_r) was used as an indicator of homogeneity. It is 6,8% for deoxynivalenol. The coefficient of variation CV_r is thus comparable to the precision data of the official method ASU §64 LFGB L 15.00-9 or DIN EN 15891/2010, see 3.6.2 (see Tab. 1). The repeatability standard deviation of the participants is given at the characteristics (4.1).

Furthermore, the homogeneity for Deoxynivalenol was characterized by the **trend line function of participants' results for chronological bottled single samples.** The maximum deviations for deoxynivalenol from the mean value of the trend line was in the range of 20% of the target standard deviation σ_{pt}´ (s. 5.2 homogeneity) and is to be judged as low.

If the criteria for sufficient homogeneity of the test material are not fulfilled on a particular parameter, the impact on the target standard deviation is checked and optionally the evaluation of the results of the participants will be done using the z´-score considering the standard uncertainty of the assigned value (see 3.8 and 3.11) [3].

2.1.2 Stability

The experience with various DLA reference materials showed good storage stability with respect to the durability of the sample (spoilage) and the content of DON/ ZEA for samples with a comparable dry mass (a_W value <0.5) and matrix. The sample material is therefore stable against microbial spoilage at room temperature and dry light-protected storage.

2.2 Sample shipment and information to the test

Two portions of test material were sent to every participating laboratory in the 6th week of 2017. The testing method was optional. The tests should be finished at March 24th 2017 the latest.

With the cover letter along with the sample shipment the following information was given to participants:

In general we recommend to homogenize a representative sample amount before analysis according to good laboratory practice, especially in case of low sample weights.

Further information see 5.3.

2.3 Results

The participants submitted their results in standard forms, which have been handed out with the samples (by email).

The finally calculated concentrations as average of duplicate determinations of both numbered samples was used for the statistical evaluation. For the calculation of the Repeatability- and Reproducibility standard deviation the single values of the double determination were used.

Queried and documented were single results, recovery and the used testing method, information on the limit of quantification, the date of the analysis and general points to the method.

In case participants submitted several results for the same parameter obtained by different methods these results were evaluated with the same evaluation number with a letter as a suffix and indication of the related method.

All 11 participants submitted at least one result in time. Due to problems with the sending of the PT samples with one participant, an extended delivery period was agreed for this.

3. Evaluation

3.1 Consensus values from participants (Assigned value)

The robust mean of the submitted results was used as assigned value (X) („consensus value from participants") providing a normal distribution. The calculation was done according to algorithm A as described in annex C of ISO 13528 [3].

The condition is that the majority of the participants' results show a normal distribution or are distributed unimodal and symmetrically. To this end, an examination of the distribution is carried out, inter alia, using the kernel density estimate [3, 12].

In case there are indications for sources of higher variability such as a bimodal distribution of results, a cause analysis is performed. Frequently different analytical methods may cause an anomaly in results' distribution. If this is the case, separate evaluations with own assigned values (X_{pti}) are made whenever possible.

The statistical evaluation is carried out for all the parameters for a minimum of 7 values are present.

The actual measurement results will be drafted. Individual results, which are outside the specified measurement range of the participating laboratory (for example with the result > 25 mg/kg or < 2,5 mg/kg) or the indicating "0" will not be considered for the statistic evaluation [3].

3.2 Robust standard deviation

For comparison to the target standard deviation σ_{pt} (standard deviation for proficiency assessment) a robust standard deviation (S^x) was calculated. The calculation was done according to algorithm A as described in annex C of ISO 13528 [3].

3.3 Repeatability standard deviation

The repeatability standard deviation S_r is based on the laboratory´s standard deviation of (outlier free) individual participant results, each under repeatability conditions, that means analyses was performed on the same sample by the same operator using the same equipment in the same laboratory within a short time. It characterizes the mean deviation of the results within the laboratories [3] and is used by DLA as an indication of the homogeneity of the sample material.

In case single results from participants are available the calculation of the repeatability standard deviation S_r, also known as standard deviation within laboratories S_w, is performed by: [3, 4].

The relative repeatability standard deviation as a percentage of the mean value is indicated as coefficient of variation CV_r in the table of statistical characteristics in the results section in case single results from participants are available.

3.4 Reproducibility standard deviation

The reproducibility standard deviation S_R represents a inter-laboratory estimate of the standard deviation for the determination of each parameter on the bases of (outlier free) individual participant results. It takes into account both the repeatability standard deviation S_r and the within-laboratory standard deviation S_S. Reproducibility standard deviations of PT´s may differ from reproducibility standard deviations of ring trials, because the participating laboratories of a PT generally use different internal conditions and methods for determining the measured values.

In the present evaluation, the specification of the reproducibility standard deviation, therefore, does not refer to a specific method, but characterizes approximately the comparability of results between the laboratories, assumed the effect of homogeneity and stability of the sample are negligible.

In case single results from participants are available the calculation of the reproducibility standard deviation S_R is performed by: [3, 4].

The relative reproducibility standard deviation as a percentage of the mean value is indicated as coefficient of variation CV_R in the table of statistical characteristics in the results section in case single results from participants are available. Its meaning is explained in more detail in 3.9.

3.5 Exclusion of results and outliers

Before statistical evaluation obvious blunders, such as those with incorrect units, decimal point errors, and results for a another proficiency test item can be removed from the data set [2]. Even if a result clearly deviates from the robust mean (e.g. factor >10) and has an influence on the robust statistics, a result can be excluded from statistical evaluation [3].

All results should be given at least with 2 significant digits. Specifying 3 significant digits is usually sufficient.

Results obtained by different analytical methods causing an increased variability and/or a bi- or multimodal distribution of results, are treated separately or could be excluded in case of too few numbers of results. For this results are checked by kernel density estimation [3, 12].

Results are identified as outliers by the use of robust statistics. If a value deviates from the robust mean by more than 3 times the robust standard deviation, it is classified as an outlier [3]. Detected outliers are stated for information only, when z-score are < -2 or > 2. Due to the use of robust statistics outliers are not excluded, provided that no other reasons are present [3].

3.6 Target standard deviation (for proficiency assessment)

The target standard deviation of the assigned value σ_{pt} (= standard deviation for proficiency assessment) can be determined according to the following methods.

If an acceptable quotient S^*/σ_{pt} is present, the target standard deviation of the general model by Horwitz is preferably used for the proficiency assessment. It is usually suitable for evaluation of interlaboratory studies, where different methods are applied by the participants. On the other hand the target standard deviation from the evaluation of precision data of an precision experiment is derived from collaborative studies with specified analytical methods.

In cases where both above-mentioned models are not suitable, the target standard deviation is determined based on values by perception, see under 3.6.3.

For information, the z-scores of both models are given in the evaluation, if available.

For the valuation of deoxynivalenol the target standard deviation from the general model of Horwitz (s. 3.6.1) was applied. Due to the increased variability the standard uncertainty was considered by valuating with z´-scores (see 3.8).

Due to the number of <7 results, a limited evaluation was performed for zearalenone:

- **The robust mean value for ZEA (34,9 µg/kg) was in good agreement with the ZEA (38 µg/kg) calculated from preliminary analysis and the mixing ratio of the raw materials and**
- **the determined values for the robust standard deviation, the repeatability standard deviation and the reproducibility standard deviation are in good agreement with the corresponding values of the comparable ASU methods.**
- **The quotient S^*/σ_{pt} of 1,3 is to be evaluated as low.**

The resulting relatively low variability of the results permits an evaluation (with limited significance). The general model of Horwitz/ Thompson was used for the evaluation of zearalenone.

3.6.1 General model (Horwitz)

Based on statistical characteristics obtained in numerous PTs for different parameters and methods Horwitz has derived a general model for estimating the reproducibility standard deviation σ_R [6]. Later the model was modified by Thompson for certain concentration ranges [10]. The reproducibility standard deviation σ_R can be applied as the relative target standard deviation σ_{pt} in % of the assigned values and calculated according to the following equations [3]. For this the assigned value X_{pt} is used for the concentration c.

Equations	**Range of concentrations**	**corresponds to**
$\sigma_R = 0{,}22c$	$c < 1{,}2 \times 10^{-7}$	< 120 µg/kg
$\sigma_R = 0{,}02c^{0{,}8495}$	$1{,}2 \times 10^{-7} \leq c \leq 0{,}138$	≥ 120 µg/kg
$\sigma_R = 0{,}01c^{0{,}5}$	$c > 0{,}138$	> 13,8 g/100g

with c = mass content of analyte (as relative size, e.g. 1 mg/kg = 1 ppm = 10^{-6} kg/kg)

3.6.2 Precision experiment

Using the reproducibility standard deviation σ_R and the repeatability standard deviation σ_r of a precision experiment (collaborative trial or proficiency test) the target standard deviation σ_{pt} can be derived considering the number of replicate measurements m of participants in the present PT [3]:

$$\sigma_{pt} = \sqrt{\sigma_R^2 - \sigma_r^2\left(m-1/m\right)}$$

The relative repeatability standard deviations (RSD_r) and relative reproducibility standard deviation (RSD_R) given in Table 1 were determined in ring tests using the indicated methods.
The resulting target standard deviations σ_{pt}, which were identified there, were used to evaluate the results and to provide additional information for the statistical data.

Table 1: relative repeatability standard deviations (RSD_r) and relative reproducibility standard deviation (RSD_R) according to selected evaluations of tests for precision and the resulting target standard deviation σ_{pt} [18, 19, 22]

Parameter	**Matrix**	**Mean**	**RSD_r**	**RSD_R**	**σ_{pt}**	**Method / Literature**
DON	Rice	458 µg/kg	6,5%	11,5%	10,5%	HPLC / 18
DON	Wheat	678 µg/kg	6,0%	16,3%	15,7%	HPLC / 18
DON	Wheat	165 µg/kg	21%	39%	36,1%	HPLC / 18
DON	Corn	501 µg/kg	10%	23%	21,9%	HPLC / 18
ZEA	Corn	87,2 µg/kg	14,2%	20,6%	18,0%	HPLC / 22
ZEA	Corn	66,5 µg/kg	8,9%	16,4%	15,1%	HPLC / 22
ZEA	Rye	26,3 µg/kg	8,9%	19,7%	18,7%	HPLC / 19
ZEA	Rye	58,4 µg/kg	3,8%	23,0%	22,8%	HPLC / 19

For the calculation of the target standard deviation **σ_{pt}** from tests for precision, which are specified for information in the evaluation (see under 4.1 and 4.2), calculated mean values are used (for **DON** RSD_r= 10,9%, RSD_R= 22,5%; for **ZEA** RSD_r= 9,0%, RSD_R= 20,0%).

3.6.3 Value by perception

In the present LVU DLA 22-2017 corn flour was to be tested for the parameters deoxynivalenol (DON) and zearalenone (ZEA). According to EU Regulation 1881/2006 [23] the following maximum levels are set for DON and ZEA:

	Erzeugnis (1)	Höchstgehalt (µg/kg)
2.4	**Deoxynivalenol** (17)	
2.4.1	Unverarbeitetes Getreide (18) (19) außer Hartweizen, Hafer und Mais	1 250
2.4.2	Unverarbeiteter Hartweizen und Hafer (18) (19)	1 750
2.4.3	Unverarbeiteter Mais (18) außer unverarbeitetem Mais, der zur Verarbeitung durch Nassmahlen (37) bestimmt ist	1 750 (20)
2.4.4	Zum unmittelbaren menschlichen Verzehr bestimmtes Getreide, Getreidemehl, als Enderzeugnis für den unmittelbaren menschlichen Verzehr vermarktete Kleie und Keime, außer den unter 2.4.7, 2.4.8 und 2.4.9 aufgeführten Lebensmitteln	750
2.4.5	Teigwaren (trocken) (22)	750
2.4.6	Brot (einschließlich Kleingebäck), feine Backwaren, Kekse, Getreide-Snacks und Frühstückscerealien	500
2.4.7	Getreidebeikost und andere Beikost für Säuglinge und Kleinkinder (3) (7)	200
2.4.8	Unter den KN-Code 1103 13 oder 1103 20 40 fallende Maismahlfraktionen mit einer Partikelgröße > 500 Mikrometer und unter den KN-Code 1904 10 10 fallende andere Maismahlerzeugnisse mit einer Partikelgröße > 500 Mikrometer, die nicht zum unmittelbaren menschlichen Verzehr bestimmt sind	750 (20)

2.5	**Zearalenon** (17)	
2.5.1	Unverarbeitetes Getreide (18) (19) außer Mais	100
2.5.2	Unverarbeiteter Mais (18) außer unverarbeitetem Mais, der zur Verarbeitung durch Nassmahlen (37) bestimmt ist	350 (20)
2.5.3	Zum unmittelbaren menschlichen Verzehr bestimmtes Getreide, Getreidemehl, als Enderzeugnis für den unmittelbaren menschlichen Verzehr vermarktete Kleie und Keime, außer den unter 2.5.6, 2.5.7, 2.5.8, 2.5.9 und 2.5.10 aufgeführten Lebensmitteln	75
2.5.4	Raffiniertes Maisöl	400 (20)
2.5.5	Brot (einschließlich Kleingebäck), feine Backwaren, Kekse, Getreide-Snacks und Frühstückscerealien, außer Mais-Snacks und Frühstückscerealien auf Maisbasis	50
2.5.6	Für den unmittelbaren menschlichen Verzehr bestimmter Mais, Snacks und Frühstückscerealien auf Maisbasis	100 (20)
2.5.7	Getreidebeikost (außer Getreidebeikost auf Maisbasis) und andere Beikost für Säuglinge und Kleinkinder (3) (7)	20
2.5.8	Verarbeitete Lebensmittel auf Maisbasis für Säuglinge und Kleinkinder (3) (7)	20 (20)
2.5.9	Unter den KN-Code 1103 13 oder 1103 20 40 fallende Maismahlfraktionen mit einer Partikelgröße > 500 Mikrometer und unter den KN-Code 1904 10 10 fallende andere Maismahlerzeugnisse mit einer Partikelgröße > 500 Mikrometer, die nicht zum unmittelbaren menschlichen Verzehr bestimmt sind	200 (20)
2.5.10	Unter den KN-Code 1102 20 fallende Maismahlfraktionen mit einer Partikelgröße ≤ 500 Mikrometer und unter den KN-Code 1904 10 10 fallende andere Maismahlerzeugnisse mit einer Partikelgröße ≤ 500 Mikrometer, die nicht zum unmittelbaren menschlichen Verzehr bestimmt sind	300 (20)

The target standard deviation for proficiency assessment can be set at a value that corresponds to the level of performance that the coordinator would wish laboratories to be able to achieve [3].

For the present evaluation the target standard deviation according to 3.6.1 were regarded suitable.

Table 2 shows selected characteristics of participants results of the present PT in comparison to the previous year.

Table 2: Characteristics of the present PT (on blue-grey) in comparison to previous PTs since 2015 (SD = standard deviation, CV = coefficient of variation)

Parameter	**rob. Mean (µg/kg)**	**rob. SD (S*) (µg/kg)**	**rel. SD (VK_r) [%]**	**rel. SD (VK_R) [%]**	**Target-SD (σ_{pt}) (µg/kg)**	**Quotient S^*/σ_{pt}**	**DLA-report**
DON	444	152	6,8	38	98,6	1,5	22-2017
ZEA	38,1	13,2	7,7	30	8,37	1,6	22-2017
DON	368	163	15,2	48,1	87,3	1,9	20-2016
ZEA	16,7	9,53	26,5	61,9	3,68	2,6	20-2016
DON	225	53,0	5,05	-	45,1	1,2	15-2015
ZEA	14,4	3,4	-	-	3,2	1,1	15-2015

3.7 z-Score

To assess the results of the participants the z-score is used. It indicates about which multiple of the target standard deviation (σ_{pt}) the result (x_i) of the participant is deviating from the assigned value (X_{pt}) [3].
Participants' z-scores are derived from:

$$z_i = \frac{\left(x_i - x_{pt}\right)}{\sigma_{pt}}$$

The requirements for the analytical performance are generally considered as fulfilled if

$$-2 \leq z \leq 2 \ .$$

The z-score valid for the PT evaluation is designated z-score (σ_{pt}), while the value of z-score (Info) is for information only. The two z-scores are calculated using the different target standard deviations according to 3.6.

3.7.1 Warning and action signals

In accordance with the norm ISO 13528 it is recommended that a result that gives rise to a *z*-score above 3,0 or below −3,0, shall be considered to give an "action signal" [3]. Likewise, a *z*-score above 2,0 or below −2,0 shall be considered to give a "warning signal". A single "action signal", or "warning signal" in two successive PT-rounds, shall be taken as evidence that an anomaly has occurred which requires investigation. For example a fault isolation or a root cause analysis through the examination of transmission error or an error in the calculation, in the trueness and precision must be performed and if necessary appropriate corrective measures should be applied [3].

In the figures of z-scores DLA gives the limits of warning and action signals as yellow and red lines respectively. According to ISO 13528 the signals are valid only in case of a number of ≥ 10 results [3].

3.8 z'-Score

The z'-score can be used for the valuation of the results of the participants, in cases the standard uncertainty has to be considered (s. 3.8). The z'-score represents the relation of the deviation of the result (x) of the participant from the respective consensus value (X) to the square root of quadrat sum of the target standard deviation ($\hat{\sigma}$) and the standard uncertainty (Ux_{pt}) [3].

The calculation is performed by:

$$z_i' = \frac{x_i - x_{pt}}{\sqrt{\sigma_{pt}^2 + u_{(x_{pt})}^2}}$$

If carried out an evaluation of the results by means of z 'score, we have defined below the expression in the denominator as a target standard deviation σ_{pt}'.

The requirements for the analytical performance are generally considered as fulfilled if

$$-2 \leq z' \leq 2 \ .$$

For warning- and action-signals see 3.7.1.

3.9 Reproducibility coefficient of variation (CV)

The variation coefficient (CV) of the reproducibility (= *relative reproducibility standard deviation)* is calculated from the standard deviation and the mean as follows [4, 13]:

$$CV_R = \frac{S_R * 100}{X}$$

In contrast to the standard deviation as a measure of the absolute variability the CV gives the relative variability within a data region. While a low CV, e.g. <5-10% can be taken as evidence for a homogeneous set of results, a CV of more than 50% indicates a "strong inhomogeneity of statistical mass", so that the suitability for certain applications such as the assessment of exceeded maximum levels or the performance evaluation of the participating laboratories possibly can not be done [3].

3.10 Quotient S^*/σ_{pt}

Following the Horrat-value the results of a proficiency-test (PT) can be considered convincing, if the quotient of robust standard deviation S* and target standard deviation σ_{pt} does not exceed the value of 2.
A value > 2 means an insufficient precision, i.e. the analytical method is too variable, or the variation between the test participants is higher than estimated. Thus the comparability of the results is not given [3].

3.11 Standard uncertainty

The consensus value has a standard uncertainty $U(X_{pt})$ that depends on the analytical method, differences between the analytical methods used, the test material, the number of participant laboratories (P) and perhaps on other factors. The standard uncertainty of the assigned value ($U_{(Xpt)}$) for this PT is calculated as follows [3]:

$$u_{(x_{pt})} = 1{,}25 \times \frac{s^*}{\sqrt{p}}$$

If $U_{(Xpt)} \leq 0{,}3\ \sigma_{pt}$ the standard uncertainty of the consensus value needs not to be included in the interpretation of the results of the PT [3]. A clear exceeded the value of 0.3 is an indication that the target standard deviation was possibly set too low for the standard uncertainty of the assigned value.

The quotient $U(X_{pt})/\sigma_{pt}$ is reported in the characteristics of the test.

4. Results

All following tables are anonymized. With the delivering of the evaluation-report the participants are informed about their individual evaluation-number.

In the first table the characteristics are listed:

Statistic Data
Number of results
Number of outliers
Mean
Median
Robust mean(X_{pt})
Robust standard deviation (S^*)
Number with 2 replicates
repeatability standard deviation (S_r)
Repeatability (Cv_r) in %
reproducibility standard deviation (S_R)
Reproducibility (CV_R) in %
Target range:
Target standard deviation σ_{pt} or σ_{pt}'
Target standard deviation (for information)
lower limit of target range ($X_{pt} - 2\sigma_{pt}$) or ($X_{pt} - 2\sigma_{pt}$') *
upper limit of target range ($X_{pt} + 2\sigma_{pt}$) or ($X_{pt} + 2\sigma_{pt}$') *
Quotient S/σ_{pt} or S*/σ_{pt}'*
Standard uncertainty $U(X_{pt})$
Quotient $U(X_{pt})/\sigma_{pt}$ or $U(X_{pt})/\sigma_{pt}$'
Results in the target range
Percent in the target range

* Target range is calculated with z-score or z'-score

In the table below, the results of the participating laboratories are formatted in 3 valid digits**:

Auswerte-nummer Evaluation number	Parameter [Einheit/ Unit]	Abweichung Deviation	Z´-Score σ_{pt}´	z-Score (Info)	Hinweis Remark

** *In the documentation part, the results are given as they were transmitted by the participants.*

4.1 Deoxynivalenol in µg/kg

Vergleichsuntersuchung / Proficiency Test

Statistic Data	
Number of results	11
Number of outliers	0
Mean	461
Median	467
Robust Mean (X)	**444**
Robust standard deviation (S*)	**152**
Number with 2 replicates	11
Repeatability SD (S_r)	31,1
Repeatability (CV_r)	6,8%
Reproducibility SD (S_R)	174
Reproducibility (CV_R)	38%
Target range:	
Target standard deviation σ_{pt}´	**98,6**
Target standard deviation (for Information)	93,8
lower limit of target range	**247**
upper limit of target range	**641**
Quotient S/σ_{pt}´*	*1,5*
Standard uncertainty $U_{(Xpt)}$	*57,3*
Quotient $U_{(Xpt)}/\sigma_{pt}$´	*0,58*
Results in the target range	*10*
Percent in the target range	*90,9%*

Comments:

The standard target deviation was evaluated using the model of Horwitz. The distribution of results showed an increased variability. Valuation was done considering the standard uncertainty by z'-score.

The target standard deviation "for information" was calculated from values by perception (ASU §64 L 15.00-9)[18], see 3.6.2.

The distribution of the results showed an increased variability. The quotient S*/σ_{pt}´ was 1,5. The robust standard deviation is comparable to those of prior PT´s (see 3.6.3). The comparability of results is given.

Repeatability- and reproducibility standard deviation are in the range of established values for the methods used (see 3.6.2).

The quotient $U(X_{pt})/\sigma_p$ (0,58) is increased, but is acceptable on the basis of the other characteristics and the use of different methods.

90,9% of the results were in the target area.

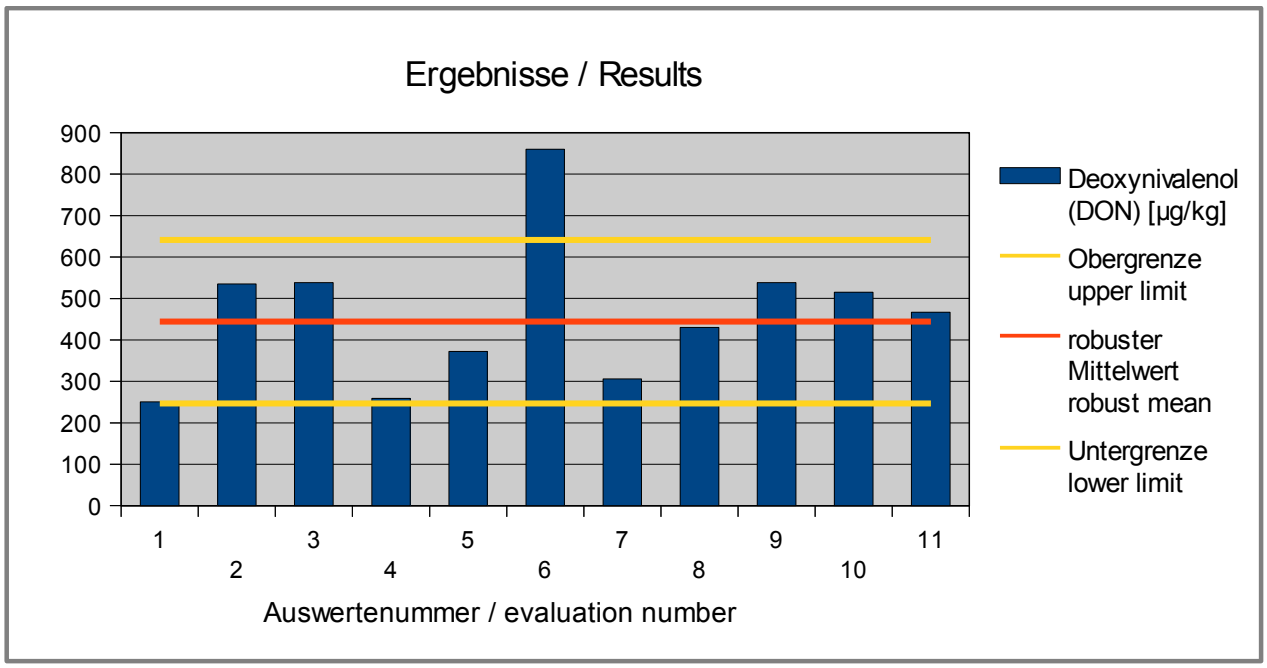

Abb. / Fig. 1: Ergebnisse/ Results Deoxynivalenol

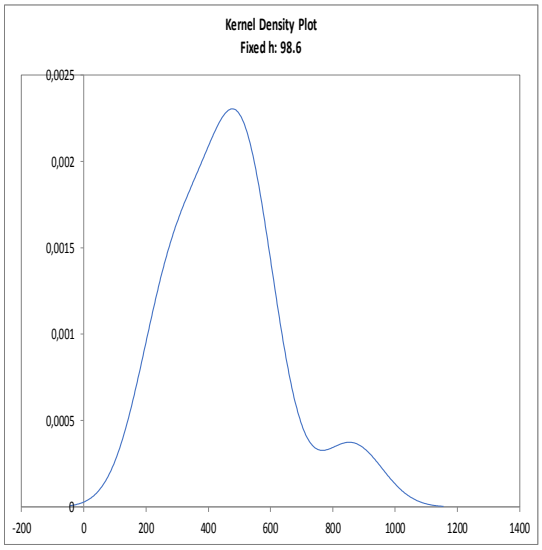

Abb. / Fig. 2:
Kerndichte-Schätzung der Ergebnisse (mit h = σ_{pt} von X_{pt} (98,6 µg/kg)

Kernel density plot of results with h = σ_{pt} *of* X_{pt} (98,6 µg/kg)

Comment:
The kernel density shows a normal distribution of results with a slight shoulder at 250 µg/kg and a side peak at 850 µg/kg, due to the result outside the target range.

Ergebnisse der teilnehmenden Institute:
Results of Participants:

Auswerte-nummer Evaluation number	Deoxynivalenol (DON) [µg/kg]	Abweichung [µg/kg] Deviation [µg/kg]	z´-Score (σ_{pt})	z-Score (Info)	Hinweis Remark
1	251	-193	-2,0	-2,1	
2	535	91,1	0,9	1,0	
3	538	94,1	1,0	1,0	
4	259	-185	-1,9	-2,0	
5	372	-71,9	-0,7	-0,8	
6	860	416	4,2	4,4	
7	306	-138	-1,4	-1,5	
8	430	-13,9	-0,1	-0,1	
9	538	94,5	1,0	1,0	
10	515	71,1	0,7	0,8	
11	467	23,1	0,2	0,2	

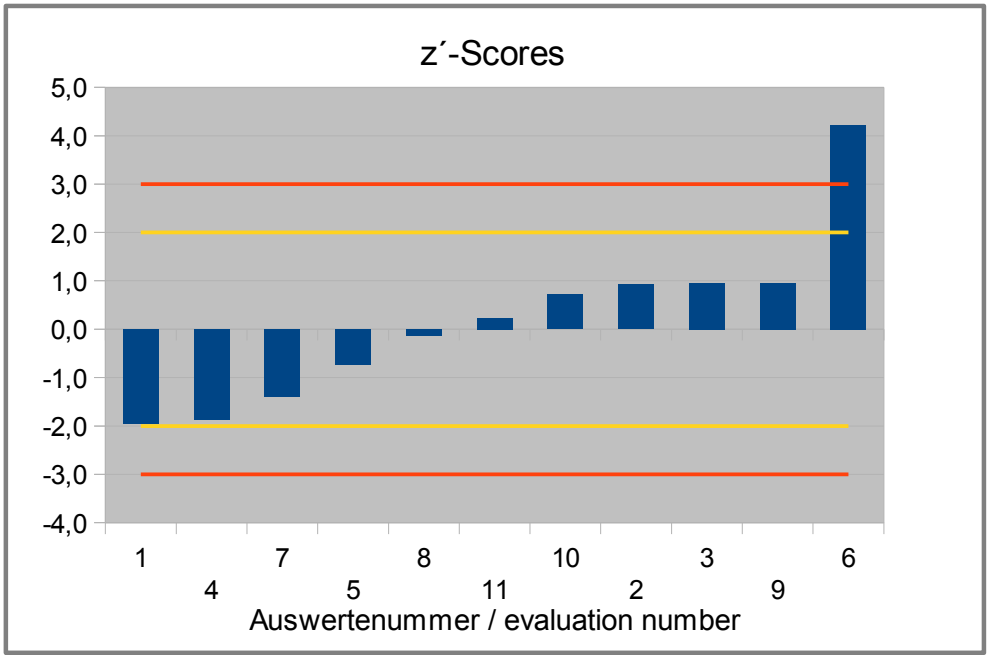

Abb. / Fig. 3: Z-Scores Deoxynivalenol

4.2 Zearalenone in µg/kg

Vergleichsuntersuchung / Proficiency Test

Statistic Data	
Number of results	6
Number of outliers	0
Mean	36,1
Median	34,8
Robust Mean (X)	**34,9**
Robust standard deviation (S*)	**10,0**
Number with 2 replicates	6
Repeatability SD (S_r)	2,73
Repeatability (CV_r)	7,7%
Reproducibility SD (S_R)	10,5
Reproducibility (CV_R)	30%
Target range:	
Target standard deviation σ_{pt}	**7,67**
Target standard deviation (for Information)	6,61
lower limit of target range	**19,5**
upper limit of target range	**50,2**
Quotient S/σ_{pt}*	*1,3*
Standard uncertainty $U_{(Xpt)}$	*5,08*
Quotient $U_{(Xpt)}/\sigma_{pt}$	*0,66*
Results in the target range	*5*
Percent in the target range	*83,3%*

Comments:

Due to the relatively low variability of the results, a statistical evaluation was carried out despite <7 results (see also under 3.6).

The standard target deviation was evaluated using the model of Horwitz/ Thompson. The target standard deviation "for information" was calculated from values by perception [19/22].

The distribution of the results showed normal variability. The quotient S^*/σ_{pt}´ was 1,3. The robust standard deviation is comparable to those of prior PT´s (see 3.6.3). The comparability of results is given.

Repeatability- and reproducibility standard deviation are in the range of established values for the methods used (see 3.6.2).

The quotient $U(X_{pt})/\sigma_p$ (0,66) is increased, but is acceptable on the basis of the other characteristics and the use of different methods.

83% of the results were in the target area.

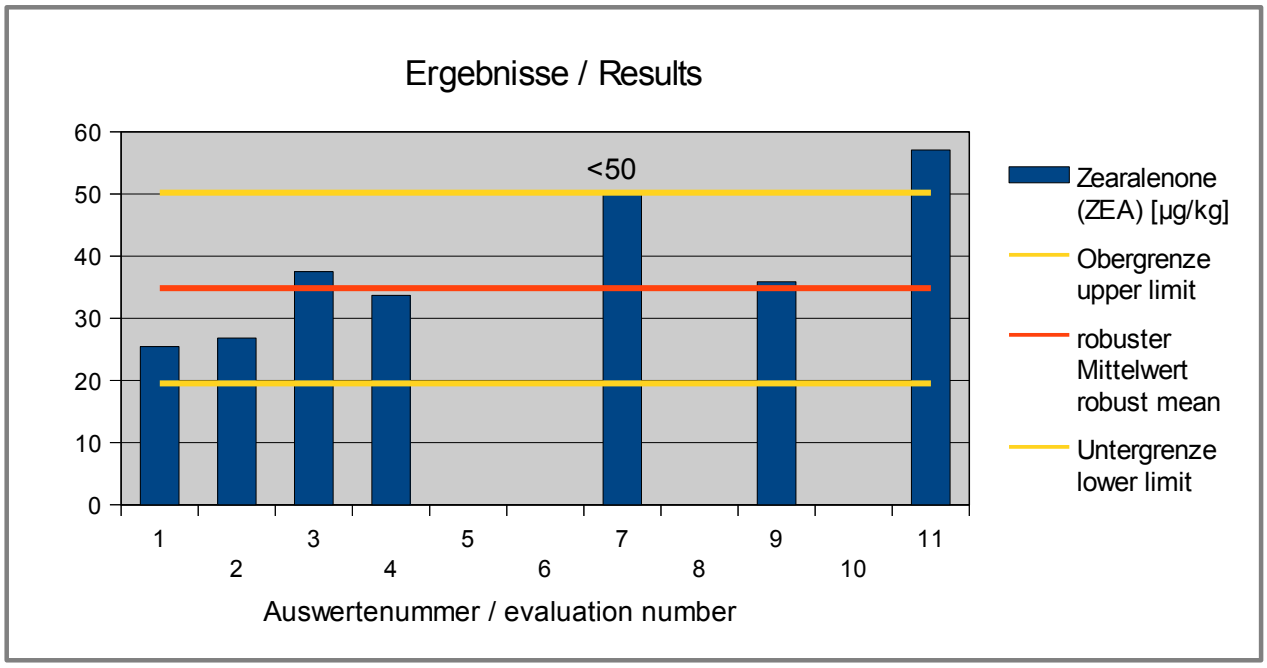

Abb. / Fig. 4: Ergebnisse/ Results Zearalenone

Abb. / Fig. 5:
Due to the low number of results, no Kernel density plot of the results could be made.

Ergebnisse der Teilnehmer:
Results of Participants:

Auswerte-nummer Evaluation number	Zearalenone (ZEA) [µg/kg]	Abweichung [µg/kg] Deviation [µg/kg]	z-Score (σ_{pt})	z-Score (Info)	Hinweis Remark
1	25,5	-9,39	-1,2	-1,4	
2	26,8	-8,06	-1,1	-1,2	
3	37,5	2,64	0,3	0,4	
4	33,7	-1,16	-0,2	-0,2	
5					
6					
7	< 50	-	-	-	Limit of detection in target range
8					
9	35,9	1,04	0,1	0,2	
10					
11	57,1	22,2	2,9	3,4	

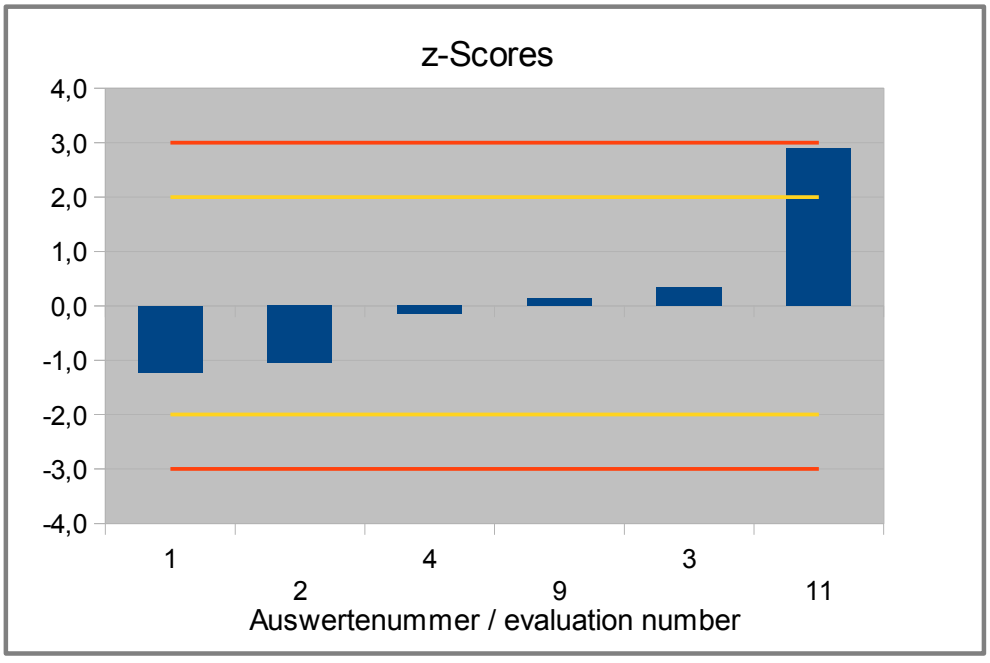

Abb. / Fig. 6: Z-Scores Zearalenone

5. Documentation

5.1 Details by participants

5.1.1 Primary data

Note: Information given in German was translated by DLA to the best of our knowledge (without guarantee of correctness).

5.1.1.1 Deoxynivalenol

Parameter	Teilnehmer	Proben-Nr. 1	Proben-Nr. 2	Datum d. Analyse	Ergebnis (Mittel)	Ergebnis 1	Ergebnis 2	Bestimmungsgrenze	Inkl. WF	Wiederfindungsrate [%]
Analyte	**Participant**	**Sample No. 1**	**Sample No. 2**	**Date of analysis**	**Result (Mean)**	**Result 1**	**Result 2**	**Limit of determination**	**Incl. RR**	**Recovery rate [%]**
				day/month	µg/kg	µg/kg	µg/kg	µg/kg	yes/no	in %
DON	1	36	39	23.02.17	250,6	261,2	240	200	no	80,1
DON	2	19	56	20.03.17	535	546	524	13	yes	95
DON	3	16	59		538	555	521	100	yes	100,5
DON	4	15	60	08.03.17	259	277	241	250	yes	78
DON	5	13	62	08.02.17	372	381	362	200	yes	110,7
DON	6	12	63	17.02.17	860	890	830	290	no	
DON	7	27	48	06.03.17	306	307	305	200	no	
DON	8	24	51	23.02.17	430	477	382		yes	94
DON	9	30	45	15.02.17	538,4	536,5	540,3	250	no	
DON	10	33	42		515*	550	480			
DON	11	9	70	21.03.17	467	464	470	10	yes	

** Mean calculated by DLA*

5.1.1.2 Zearalenone

Parameter	Teilnehmer	Proben-Nr. 1	Proben-Nr. 2	Datum d. Analyse	Ergebnis (Mittel)	Ergebnis 1	Ergebnis 2	Bestimmungsgrenze	Inkl. WF	Wiederfindungsrate [%]
Analyte	**Participant**	**Sample No. 1**	**Sample No. 2**	**Date of analysis**	**Result (Mean)**	**Result 1**	**Result 2**	**Limit of determination**	**Incl. RR**	**Recovery rate [%]**
				day/month	µg/kg	µg/kg	µg/kg	µg/kg	yes/no	in %
ZEA	1	36	39	23.02.17	25,47	26,07	24,87	20	no	79,5
ZEA	2	19	56	20.03.17	26,8	28,9	24,6	3,4	yes	98
ZEA	3	16	59		37,5	34,9	40,1	10	yes	101,8
ZEA	4	15	60	02.03.17	33,7	35	32,4	20	yes	97
ZEA	5	13	62							
ZEA	6	12	63		n.d.					
ZEA	7	27	48	06.03.17	< 50	< 50	< 50	50	no	
ZEA	8	24	51							
ZEA	9	30	45	15.02.17	35,9	36,8	35	25	no	
ZEA	10	33	42							
ZEA	11	9	70	21.03.17	57,1	57,1	51,4	10	yes	

5.1.2 Analytical methods

5.1.2.1 Deoxynivalenol

Parameter	Teil-neh-mer	Methodenbeschreibung	Probenvorbereitung	Messmethode	Kalibrierung und Referenzmaterial	Wiederfindung mit gleicher Matrix	Methode ak-kreditiert	Sonstige Hinweise
Analyte	Partici-pant	Method description	Sample preparation	Measuring method	Calibration and reference material	Recovery with same matrix	Method accredi-ted	Further remarks
						yes/no	yes/no	
DON	1	LC-MS/MS	-	-	yes	yes	yes	-
DON	2	LC-MS/MS	solid/ liquid extraction	MS/MS	Calibration in matrix, certified reference material as quality control	no	no	
DON	3	DIN EN 15891		LC-MS/MS	ext. standards, isotope-labelled internal standard	yes	yes	
DON	4	ASU §64 L 15.00-9	IAC ImmSorb DON (Coring)	HPLC with UV-detector	Deoxynivalenol (Fluka) DLA 15/2015	no (corn flour)	yes	
DON	5			ELISA/r-biopharm/ Fast-DON		yes	yes	
DON	6					no	no	
DON	7	r-biopharm Ridascreen Fast DON					no	
DON	8				Biopure	yes	yes	
DON	9	Internal method				yes	yes	
DON	10							
DON	11	LC/MS/MS standard addition	Extraction with 84 % acetonitrile in water	LC/MS/MS	Coring Myco Mix 4	yes	yes	

IAC = immunoaffinity column

5.1.2.2 Zearalenone

Parameter	Teil-nehmer	Methodenbeschrei-bung	Probenvorbereitung	Messmethode	Kalibrierung und Referenzmaterial	Wiederfindung mit gleicher Matrix	Methode ak-kreditiert	Sonstige Hinweise
Analyte	**Partici-pant**	**Method description**	**Sample preparation**	**Measuring method**	**Calibration and reference material**	**Recovery with same matrix**	**Method accredi-ted**	**Further remarks**
						yes/no	yes/no	
ZEA	1	LC-MS/MS	-	-	yes	yes	yes	-
ZEA	2	LC-MS/MS	solid/ liquid-extraction	MS/MS	Calibration in matrix, certified reference material as quality control	no	no	
ZEA	3	HM SUI S Ch 42		LC-MS/MS	ext. standards, isotope-labelled internal standard	yes	yes	
ZEA	4	ASU §64 L 15.01/02-2	IAC ZearaStar COIAL 4000 (Romer Labs Diagnostic GmbH)	HPLC with fluorescence-detector	Zearalenone (Sigma) DLA 11/2013	no (corn flour)	yes	
ZEA	5							
ZEA	6							
ZEA	7	r-biopharm Ridascreen Fast ZEA					no	
ZEA	8							
ZEA	9	internal method				yes	yes	
ZEA	10							
ZEA	11	LC/MS/MS standard addition	Extraction with 84 % acetonitrile in water	LC/MS/MS	Coring Myco Mix 4	yes	yes	

IAC = immunoaffinity column

5.2 Homogeneity

5.2.1 Homogeneity testing before PT

The **mixture homogeneity before bottling** was examined 10-fold by **microtracer analysis.**

Microtracer Homogeneity Test DLA 33-2016		
Weight whole sample	4,01	kg
Microtracer	FSS-rot lake	
Particle size	75 – 300	µm
Weight pro particle	2,0	µg
Addition of tracer	19,8	mg/kg

Result of analysis:

Sample	Weight [g]	Particle number	Particles [mg/kg]
1	9,65	98	20,3
2	10,31	109	21,1
3	9,78	92	18,8
4	10,72	89	16,6
5	9,84	98	19,9
6	10,26	111	21,6
7	9,43	94	19,9
8	9,40	83	17,7
9	10,74	105	19,6
10	9,65	92	19,1

Poisson destribution		
Number of samples	10	
Degree of freedom	9	
Mean	97,1	Partikel
Standard deviation	7,57	Partikel
χ^2 (CHI-Quadrat)	5,31	
Prohability	**81**	%
Recovery rate	98,5	%

Normaldistribution		
Number of samples	10	
Mean	19,5	mg/kg
Standard deviation	1,52	mg/kg
rel. Standard deviation	7,8	%
Horwitz standard deviation	10,2	%
HorRat-value	**0,8**	
Recovery rate	98,5	%

5.2.2 Comparison of sample number/test results and trend line

By comparison of the **increasing sample numbers** and the measurement results of DON, the homogeneity of the chronological bottled PT item can be characterized with the help of the trend line function:

DON				
Target standard deviation σ_{pt}	98,6			µg/kg
Sample numbers	9 - 70			
Total numbers of samples	22			
Slope	-2,06			
Trend line range	484	-	439	µg/kg
Deviation trend line	462	±	22,5	µg/kg
Percent of σpt	22,8	%		

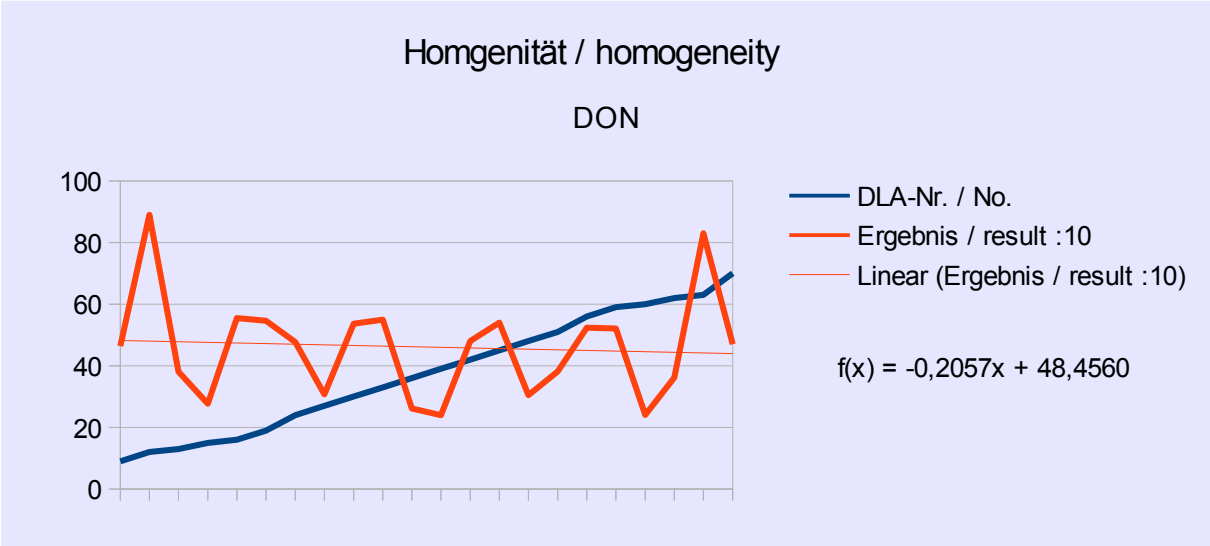

Abb./Fig. 7:
Trendfunktion Probennummern vs. Ergebnisse (1/10 dargestellt)
trend line function sample number vs. results (1/10 plotted)

5.3 Sample cover letter: Information on the Proficiency Test (PT)

Before the PT, the participants are given the following information in the sample cover letter:

Information on the Proficiency Test (PT)

PT number	***DLA 22-2017***
PT name	***DON + Zearalenon in Cereals***
*Sample matrix**	*Samples A + B: Mixture of corn flour varieties, wheat flour approx. 10%*
Number of samples and sample amount	*2 identical samples a + B, 50 g each.*
Storage	*Samples A + B: cooled 2 - 10°C*
Intentional use	*Laboratory use only (quality control samples)*
Parameter	*quantitative: Deoxynivalenol (DON), Zearalenone (ZEA), further results possible.*
Methods of analysis	*Analytical methods are optional*
Notes to analysis	*The analysis of PT samples should be performed like a routine laboratory analysis.* *In general we recommend to homogenize a representative sample amount before analysis according to good laboratory practice, especially in case of low sample weights.*
Result sheet	*The final results are given. They are calculated from the double determination (samples A and B). The recovery, if carried out, is to be included in the calculation.* *The results for sample A and B should be filled in the result submission file.*
Units	*µg/kg*
Number of significant digits	*at least 2*
Further information	*For information please specify:* – *Date of analysis* – *DLA-sample-numbers (for sample A and B)* – *Limit of detection* – *Assignment incl. Recovery* – *Recovery with the same matrix* – *Method is accredited*
Result submission	*The result submission file should be sent by e-mail to:* ***pt@dla-lvu.de***
Deadline	***the latest March 17th 2017***
Evaluation report	*The evaluation report is expected to be completed 6 weeks after deadline of result submission and sent as PDF file by e-mail.*
Coordinator and contact person of PT	*Dr. Gerhard Wichmann*

* Control of mixture homogeneity and qualitative testings are carried out by DLA. Testing of the content, homogeneity and stability of PT parameters is subcontracted by DLA.

6. Index of participant laboratories

Teilnehmer/ Participant	Ort/ Town	Land/ Country
		Austria
		Germany
		Germany
		Germany
		Croatia
		Austria
		Germany
		Germany
		Germany
		Germany
		Germany

[Die Adressdaten der Teilnehmer wurden für die allgemeine Veröffentlichung des Auswerte-Berichts nicht angegeben.]

[The address data of the participants were deleted for publication of the evaluation report.]

7. Index of literature

1. DIN EN ISO/IEC 17025:2005; Allgemeine Anforderungen an die Kompetenz von Prüf- und Kalibrierlaboratorien / General requirements for the competence of testing and calibration laboratories
2. DIN EN ISO/IEC 17043:2010; Konformitätsbewertung – Allgemeine Anforderungen an Eignungsprüfungen / Conformity assessment – General requirements for proficiency testing
3. ISO 13528:2015 & DIN ISO 13528:2009; Statistische Verfahren für Eignungsprüfungen durch Ringversuche / Statistical methods for use in proficiency testing by interlaboratory comparisons
4. ASU §64 LFGB: Planung und statistische Auswertung von Ringversuchen zur Methodenvalidierung / DIN ISO 5725 series part 1, 2 and 6 Accuracy (trueness and precision) of measurement methods and results
5. Verordnung / Regulation 882/2004/EU; Verordnung über über amtliche Kontrollen zur Überprüfung der Einhaltung des Lebensmittel- und Futtermittelrechts sowie der Bestimmungen über Tiergesundheit und Tierschutz / Regulation on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules
6. Evaluation of analytical methods used for regulation of food and drugs; W. Horwitz; Analytical Chemistry, 54, 67-76 (1982)
7. The International Harmonised Protocol for the Proficiency Testing of Ananlytical Laboratories ; J.AOAC Int., 76(4), 926 – 940 (1993)
8. A Horwitz-like funktion describes precision in proficiency test; M. Thompson, P.J. Lowthian; Analyst, 120, 271-272 (1995)
9. Protocol for the design, conduct and interpretation of method performance studies; W. Horwitz; Pure & Applied Chemistry, 67, 331-343 (1995)
10. Recent trends in inter-laboratory precision at ppb and sub-ppb concentrations in relation to fitness for purpose criteria in proficiency testing; M. Thompson; Analyst, 125, 385-386 (2000)
11. The International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories; Pure Appl Chem, 78, 145 – 196 (2006)
12. AMC Kernel Density - Representing data distributions with kernel density estimates, amc technical brief, Editor M Thompson, Analytical Methods Committee, AMCTB No 4, Revised March 2006 and Excel Add-in Kernel.xla 1.0e by Royal Society of Chemistry
13. EURACHEM/CITAC Leitfaden, Ermittlung der Messunsicherheit bei analytischen Messungen (2003); Quantifying Uncertainty in Analytical Measurement (1999)GMP+ Feed Certification scheme, Module: Feed Safety Assurance, chapter 5.7 Checking procedure for the process accuracy of compound feed with microtracers in GMP+ BA2 Control of residues, Version: 1st of January 2015 GMP+ International B.V.

14. GMP+ Feed Certification scheme, Module: Feed Safety Assurance, chapter 5.7 Checking procedure for the process accuracy of compound feed with micro tracers in GMP+ BA2 Control of residues, Version: 1st of January 2015 GMP+ International B.V.

15. MTSE SOP No. 010.01 (2014): Quantitative measurement of mixing uniformity and carry-over in powder mixtures with the rotary detector technique, MTSE Micro Tracers Services Europe GmbH

16. EG-VO 401-2006 zur Festlegung der Probenahmeverfahren und Analysemethoden für die amtliche Kontrolle des Mykotoxingehalts von Lebensmitteln

17. EU-VO 519/2014 zur Änderung der Verordnung (EG) Nr. 401/2006 hinsichtlich der Probenahmeverfahren für große Partien, Gewürze und Nahrungsergänzungsmittel, der Leistungskriterien für die Bestimmung von T-2-Toxin, HT-2-Toxin und Citrinin sowie der Screening-Methoden für die Analyse (v. 16. Mai 2014)

18. ASU §64 LFGB L 15.00-9 (entspricht DIN EN 15891/2010): Bestimmung von Deoxynivalenol in Getreide, Getreideerzeugnissen und Säuglings- und Kleinkindernahrung auf Getreidebasis; HPLC-Verfahren (Februar 2014)

19. ASU §64 LFGB L 15.01/02-2: Bestimmung von Zearalenon in Weizen und Roggen (Dezember 2006)

20. ASU §64 LFGB L 16.01-8: Bestimmung von Zearalenon in Gerstenmehl, Maismehl und Weizenmehl (Januar 2011)

21. ASU §64 LFGB L 16.02-1: Bestimmung von Zearalenon in Maisgrieß (Januar 2011)

22. ASU §64 LFGB L 48.02-3: Bestimmung von Zearalenon in Säuglings- und Kleinkindernahrung (Januar 2011)

23. EU VO 1881/2006 zur Festsetzung der Höchstgehalte für bestimmte Kontaminanten in Lebensmitteln/ setting maximum levels for certain contaminants in foodstuffs (16.12.2006)