Performance Parameters, Measurement Uncertainties, Decision Rules

General Information on measurement uncertainty

How is the term *measurement uncertainty* defined?	The international definition for m*easurement uncertainty* is: "Parameter, associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand (the analytical result)". [1] *Measurement uncertainty* can be regarded as the variability around the reported results, which is quantified as the value "U" or "2u" and within which the "true" result may be expected to lie. [1] In food analysis, the range "a ± 2u" or "a ± U" represents a 95% level of confidence in which the true value would be found, where "a" is the best estimate of the true value of the concentration of the measurand and "u" is the standard uncertainty to 68% level of confidence and "U" (equal to 2u) is the *expanded measurement uncertainty* to 95% level of confidence. [1, 4]
Does the *measurement uncertainty* arise from both sampling and analysis?	Measurement uncertainty applies to the whole measurement process which also includes the sampling. However, as the laboratory often has no control over the sampling process, the herein stated values only consider uncertainties arising from the sample preparation and the analytical measurement. [1]
How is the *measurement uncertainty* commonly estimated?	There are many procedures available for estimating the *measurement uncertainty* of a result. Commonly, the reproducibility standard deviation s_R is used (s_R equals "u"). Provided that the measurements are under statistical control, the reproducibility standard deviation s_R is applicable for all measurements within the validated scope of the standard operating procedure. The reproducibility s_R for a certain method in a laboratory can be calculated in different ways, for example derived from validation data or data obtained from quality control charts (QCC) or from proficiency testing. The *expanded measurement uncertainty* "U" might be used for estimating the expected variation of results obtained for one homogeneous sample in different laboratories (for example in ring trials / proficiency testing). [1, 2, 3, 4]
How is the *measurement uncertainty* of different methods estimated with Intertek Food Services?	The reproducibility standard deviation s_R (relative percentage: % rel) for a certain method is commonly determined based on validation data or data obtained from quality control charts (QCC). Based on s_R , the *expanded measurement uncertainty* "U" is estimated using a coverage factor of 2 (95% level of confidence). [2]

Decision Rules

Decision Rule	Rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement (see ISO 17025, terms and definitions).
How are decision rules handled with Intertek Food Services?	Statements of conformity are given in accordance with chapter 7.8.6 of ISO 17025:2018. In case a specification is defined for a certain parameter (by a standard, the customer, etc.) and a measurement result including the expanded measurement uncertainty is clearly distinguishable from the threshold value, the conformity statement contains information about the compliance or non-compliance with the specification. If the range of the expanded measurement uncertainty around the result touches or includes the specification value, the conformity statement

	additionally contains information that the given assessment is insecure. The risk of a false acceptance or rejection of a product is addressed. *Note: In case a decision rule is predefined e.g. in a standard, this is taken as basis for conformity assessment.*

Typical measurement uncertainties and other performance parameters of selected tests

Bioanalytical methods

Cultural methods, quantitative

Remarks:
In contrast to typical chemical and physico-chemical test methods cultural methods for the quantitative determination of specific germs show a lognormal distribution of measurement results.
This is due to the exponential growth characteristics of germs. In order to statistically handle this, data are logarithmized and then can be processed in the same way as "usual" data.

Calculation Example:
Surface colony count (method see below) result: 1000 cfu;
$\log_{10}(1000) = 3$
Reproducibility standard deviation *sR*: ±0,50 $\log_{10}$ cfu
Reproducibility standard deviation *sR (range): 2,5 – 3,5* $\log_{10}$ cfu
Reproducibility standard deviation *sR (range*): $10^{2,5} - 10^{3,5}$ cfu = 316 – 3162 cfu
Expanded measurement uncertainty U (range): 2 – 4 $\log_{10}$ cfu
Expanded measurement uncertainty U (range): 100 – 10000 cfu

Parameter (group)	**Uncertainty parameter**	**Value**
Aerobic mesophilic count DIN EN ISO 4833-2	Reproducibility standard deviation *sR*	± 0.25 log10 cfu
Aerobic spores inhouse method	Reproducibility standard deviation *sR*	± 0.45 log10 cfu
Anaerobic mesophilic count inhouse method	Reproducibility standard deviation *sR*	± 0.25 log10 cfu
Anaerobic Spores inhouse method	Reproducibility standard deviation *sR*	± 0.5 log10 cfu
Bacillus cereus, aerobic spore forming bacteria DIN EN ISO 7932	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Clostridia ISO 15213	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Clostridium botulinum spores inhouse method	Reproducibility standard deviation *sR*	± 0.5 log10 cfu
Clostridium perfringens DIN EN ISO 7937	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Coliforms and E. coli ISO 4832, etc.	Reproducibility standard deviation *sR*	± 0.30 log10 cfu
Enterobacteriaceae DIN ISO 21528-2	Reproducibility standard deviation *sR*	± 0.25 log10 cfu

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
Enterococci DIN 10106	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Yeasts and moulds (also osmotolerant) LFGB ASU L 01.00-37, ISO 21527-1/2	Reproducibility standard deviation *sR*	Yeasts: ± 0.30 log10 cfu; Moulds: ± 0.25 log10 cfu
Lactobacilli DIN 10168	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Listeria monocytogenes DIN EN ISO 11290-2	Reproducibility standard deviation *sR*	± 0.25 log10 cfu
Lactic acid bacteria ISO 15214	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Non-sterile products Ph.Eur 2.6.12	Reproducibility standard deviation *sR*	± 0.50 log10 cfu
Surface colony count (fitment and utensils) DIN 10113-1/2/3	Reproducibility standard deviation *sR*	± 0.50 log10 cfu
Paenibacillus larvae FLI Meth. 2a	Reproducibility standard deviation *sR*	± 0.50 log10 cfu
Pseudomonas spp. DIN EN ISO 13720	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Staphylococci DIN EN ISO 6888-1	Reproducibility standard deviation *sR*	± 0.20 log10 cfu
Campylobacter spp. (detection) DIN EN ISO 10272-1	Limit of detection	1 cfu in 25g sample

PCR methods, microorganisms

Parameter (group)	Parameter	Value
Botulinum neurotoxin forming Clostridia (detection) ISO/TS 17919	Limit of detection	1 cfu in 25g sample
Clostridium perfringens (detection) Kit method	Limit of detection	1 cfu in 25g sample
EHEC (detection) Inhouse method	Limit of detection	5 genome copies
Listeria (detection) LFGB ASU L 00.00-95(V)	Limit of detection	1 - 3 cfu in 25g
Salmonella (detection) LFGB ASU L 00.00-98	Limit of detection	1 - 3 cfu in 25g

PCR methods, viruses

Parameter (group)	Parameter	Value
Hepatitis A (detection) DIN CEN ISO/TS 15216-2	Limit of detection	200 gene copies in 25g sample
Norovirus (detection) LFGB L25.04.01-1	Limit of detection	200 gene copies in 25g sample

PCR methods, Plants, GMO

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Parameter	Value
Cotton DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Cotton DNA in sample DNA
Maize DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Maize DNA in sample DNA
Maize, soy, rapeseed, cotton DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Maize, soy, rapeseed, cotton DNA in sample DNA
Rapeseed DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Rapeseed DNA in sample DNA
Rice DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Rice DNA in sample DNA
Soy DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % Soy DNA in sample DNA
A5547-127 LibertyLink -Soya (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
Cauliflower Mosaic Virus (CaMV)-DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % CaMV DNA in sample DNA
Bt11-Maize DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
Cry1AB-DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
pat/bar-DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
CTP2:CP4 EPSPS-DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
GMO Pollen honey(detection) inhouse method	Limit of detection	0.01 % genetically modified DNA in sample DNA
GMO screening food, feed, seed (detection) LFGB ASU L 00.00-122	Limit of detection	0.01 % genetically modified DNA in sample DNA
GMO plants, GMO events (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
MON 810 DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
T25-Maize DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
RoundupReady Soya DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
RoundupReady Rapeseed DNA (detection) DIN EN ISO 21570 mod.	Limit of detection	0.01 % genetically modified DNA in sample DNA
MON40-3-2 Soy DNA (quantification) DIN EN ISO 21570 mod.	Reproducibility standard deviation *sR*	± 20%

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Parameter	Value
MON89788 Soy DNA (quantification) EU-RL GMFF, QT-EVE-GM-006	Reproducibility standard deviation *sR*	± 20

PCR methods, Animal Speciation

Parameter (group)	Parameter	Value
Atlantic Mackerel (detection) inhouse method	Limit of detection	7 genome copies
Animal Species Real Time PCR (detection) DIN EN ISO 21570 mod.	Limit of detection	appr. 0,025% (ruminants: 0.1%) of total DNA
Animal Species End Point PCR (detection) DIN EN ISO 21570 mod.	Limit of detection	10 DNA copies

Authenticity **Honey**: Stable Isotope Methods

Parameter (group)	Uncertainty parameter	Value
C4-Sugars $\Delta\delta^{13}C$ (P-H) AOAC 998.12	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs (≈ 2 % C4 sugars)
$\delta^{13}C$ Fructose inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
$\delta^{13}C$ Glucose inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
$\delta^{13}C$ Disaccharides inhouse method	Reproducibility standard deviation *sR*	0.3 ‰ abs
	Expanded measurement uncertainty U	0.6 ‰ abs
$\delta^{13}C$ Trisaccharides inhouse method	Reproducibility standard deviation *sR*	0.5 ‰ abs
	Expanded measurement uncertainty U	1.0 ‰ abs
$\delta^{13}C$ Oligosaccharides inhouse method	Reproducibility standard deviation *sR*	0,5 ‰ abs (at 1 % level)
	Expanded measurement uncertainty U	1,0 ‰ abs (at 1 % level)
$\Delta\delta^{13}C$ (max) inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
$\Delta\delta^{13}C$ (F-G) inhouse method	Reproducibility standard deviation *sR*	0.15 ‰ abs

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
	Expanded measurement uncertainty U	0.3 ‰ abs
Semiquantitative determination of sugar portion inhouse method	Reproducibility standard deviation *sR*	20 % abs (at 1 % level)

Authenticity **Agave** syrup: Stable Isotope Methods

Parameter (group)	Uncertainty parameter	Value
$\delta^{13}C$ agave bulk inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
$\delta^{13}C$ Fructose inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
$\delta^{13}C$ Glucose inhouse method	Reproducibility standard deviation *sR*	0.2 ‰ abs
	Expanded measurement uncertainty U	0.4 ‰ abs
	Reproducibility standard deviation *sR*	0.4 ‰ abs (at 3 % level)
	Expanded measurement uncertainty U	0.8 ‰ abs (at 3 % level)
	Reproducibility standard deviation *sR*	0.6 ‰ abs (at 1% level)
	Expanded measurement uncertainty U	1.2 ‰ abs (at 1 % level)
$\Delta\delta^{13}C$ (F-G) inhouse method	Reproducibility standard deviation *sR*	0.3 ‰ abs
	Expanded measurement uncertainty U	0.6 ‰ abs

Photometry, Titration, etc.

Parameter (group)	Uncertainty parameter	Value
Acidity, free (honey) inhouse method	Reproducibility standard deviation *sR*	± 5 % rel
	Expanded measurement uncertainty U	± 10 % rel
Acid number (Fats, oils) DGF C-V 2 (06)	Reproducibility standard deviation *sR*	± 9 % rel
	Expanded measurement uncertainty U	± 17 % rel
Acid number Wax DGF M-IV 2	Reproducibility standard deviation *sR*	± 2.6 % rel
	Expanded measurement uncertainty U	± 5.2 % rel
Acid number, free acidity (animal feed) VDLUFA III; 5.4.5 / 5.2.1	Reproducibility standard deviation *sR*	± 9 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
	Expanded measurement uncertainty U	± 17 % rel
Ash gravimetric DIN 10755, IFU MA 9, etc.	Reproducibility standard deviation *sR*	± 1.4 % rel
	Expanded measurement uncertainty U	± 2.8 % rel
Ash, insoluble in HCl VDLUFA III, 8.2	Reproducibility standard deviation *sR*	± 10 % rel
	Expanded measurement uncertainty U	± 20 % rel
Chloride DIN EN ISO 5943	Reproducibility standard deviation *sR*	± 0.6 % rel
	Expanded measurement uncertainty U	± 1.8 % rel
Colour (Hanna) inhouse method	Reproducibility standard deviation *sR*	± 2 mm Pfund
	Expanded measurement uncertainty U	± 4 mm Pfund
Crude fibre VDLUFA III, 6.1.1 mod.	Reproducibility standard deviation *sR*	± 5 % rel
	Expanded measurement uncertainty U	± 10 % rel
Diastase, inhouse method also for thermoresistant enzymes	Reproducibility standard deviation *sR*	± 3.6 % rel
	Expanded measurement uncertainty U	± 7.2 % rel
Diastase, Phadebas IHC 6 (2009)	Reproducibility standard deviation *sR*	± 5 % rel
	Expanded measurement uncertainty U	± 9 % rel
Diastase, Schade §64 LFGB L 40.00-1 mod.	Reproducibility standard deviation *sR*	± 3.6 % rel
	Expanded measurement uncertainty U	± 7.2 % rel
Dietary Fibre LFGB ASU L 00.00-18 mod.	Reproducibility standard deviation *sR*	± 1.4 % rel
	Expanded measurement uncertainty U	± 2.8 % rel
Dry soluble residue (Brix) LFGB ASU L 41.00-1, IFU MA 8	Reproducibility standard deviation *sR*	± 0.4 % rel
	Expanded measurement uncertainty U	± 0.8 % rel
Dry matter LFGB ASU L 15.00-6 mod., LFGB ASU L 06.00-3 mod., etc.	Reproducibility standard deviation *sR*	± 1.0 % rel
	Expanded measurement uncertainty U	± 2.0 % rel
Electrical Conductivity DIN 10753	Reproducibility standard deviation *sR*	± 2.7 % rel
	Expanded measurement uncertainty U	± 5.5 % rel
Ethanol IFU MA 52	Reproducibility standard deviation *sR*	Honey: ± 2.1 % rel Fruit: ± 8 % rel
	Expanded measurement uncertainty U	Honey: ± 4.2 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
		Fruit: ± 16 % rel
Ferment soluble crude protein VDLUFA III, 4.2.1	Reproducibility standard deviation *sR*	± 4.0 % rel
	Expanded measurement uncertainty U	± 8.0 % rel
Filling quantity inhouse method	Reproducibility standard deviation *sR*	± 1.4 % rel
	Expanded measurement uncertainty U	± 2.8 % rel
Flavonoids (Hyperoside method) inhouse method	Reproducibility standard deviation *sR*	± 4.6 % rel
	Expanded measurement uncertainty U	± 9.2 % rel
Fat, total/crude LFGB ASU L 06.00-6 mod., VDLUFA III, 5.1.1 mod.	Reproducibility standard deviation *sR*	± 3.4 % rel
	Expanded measurement uncertainty U	± 6.8 % rel
Glycerin Kit method	Reproducibility standard deviation *sR*	± 2.6 % rel
	Expanded measurement uncertainty U	± 5.2 % rel
Humidity/Moisture (honey, refractometry) LFGB ASU L 40.00-2	Reproducibility standard deviation *sR*	± 0.4 % rel
	Expanded measurement uncertainty U	± 0.8 % rel
Hydroxyproline LFGB ASU L 06.00-8	Reproducibility standard deviation *sR*	± 12.0 % rel
	Expanded measurement uncertainty U	± 25.0 % rel
Invertase activity DIN 10759-1	Reproducibility standard deviation *sR*	± 1.8 % rel
	Expanded measurement uncertainty U	± 3.6 % rel
Iodine number DGF C-V 11d	Reproducibility standard deviation *sR*	± 2.5 % rel
	Expanded measurement uncertainty U	± 5.0 % rel
Melting point LFGB ASU L 13.00-21 mod.; VDLUFA III, 5.4.6 mod.	Reproducibility standard deviation *sR*	± 1.2 % rel
	Expanded measurement uncertainty U	± 2.4 % rel
Optical rotation IHC 11	Reproducibility standard deviation *sR*	± 0.3 % rel
	Expanded measurement uncertainty U	± 0.6 % rel
Peroxide number DGF C-VI 6a, VDLUFA III, 5.4.3	Reproducibility standard deviation *sR*	± 15 % rel
	Expanded measurement uncertainty U	± 31 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
Peroxide number Wax, Ph. Eur. 01/2016:20505; Method A, mod.	Reproducibility standard deviation *sR*	± 7 % rel
	Expanded measurement uncertainty U	± 14 % rel
pH value IFU MA 11, IHC 4, etc.	Reproducibility standard deviation *sR*	± 1.6 % rel
	Expanded measurement uncertainty U	± 3.3 % rel
Phosphate IFU MA 50	Reproducibility standard deviation *sR*	± 1.0 % rel
	Expanded measurement uncertainty U	± 2.0 % rel
Polyphenols total (Folin Ciocalteu) LFGB ASU L 47.00-10	Reproducibility standard deviation *sR*	± 7 % rel
	Expanded measurement uncertainty U	± 14 % rel
Proline LFGB ASU L 40.00-3, IFU MA 49	Reproducibility standard deviation *sR*	± 3.0 % rel
	Expanded measurement uncertainty U	± 6.0 % rel
Protein Kjeldahl LFGB ASU L 06.00-7	Reproducibility standard deviation *sR*	± 1.0 % rel
	Expanded measurement uncertainty U	± 2.0 % rel
Salt content VDLUFA III, 10.5.2	Reproducibility standard deviation *sR*	± 0.8 % rel
	Expanded measurement uncertainty U	± 1.6 % rel
Saponification number (Fats, oils) DGF C-V 3	Reproducibility standard deviation *sR*	± 2.6 % rel
	Expanded measurement uncertainty U	± 5.1 % rel
Acid number Wax DGF M-IV 2	Reproducibility standard deviation *sR*	± 3.7 % rel
	Expanded measurement uncertainty U	± 7.4 % rel
Sediment DIN 10743 mod.	Reproducibility standard deviation *sR*	± 19 % rel
	Expanded measurement uncertainty U	± 39 % rel
Starch polarimetric EU VO 152/2009, meth. L	Reproducibility standard deviation *sR*	± 0.9 % rel
	Expanded measurement uncertainty U	± 1.8 % rel
Sulfite DIN EN 1988-1	Reproducibility standard deviation *sR*	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel
Sugars (Luff-Schoorl) EU VO 152/2009, method J	Reproducibility standard deviation *sR*	± 3.7 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
	Expanded measurement uncertainty U	± 7.3 % rel
TVB-N LFGB L 10.00-3 mod.	Reproducibility standard deviation *sR*	± 10 % rel
	Expanded measurement uncertainty U	± 20 % rel
Unsaponifiable matter DGF C-III 1	Reproducibility standard deviation *sR*	± 3.9 % rel
	Expanded measurement uncertainty U	± 7.8 % rel
Water activity Proprietary method (labmaster AW)	Reproducibility standard deviation *sR*	± 0.1 % rel
	Expanded measurement uncertainty U	± 0.2 % rel
Water content LFGB ASU L 13.00-39	Reproducibility standard deviation *sR*	± 2.5 % rel
	Expanded measurement uncertainty U	± 5.0 % rel

HPLC methods

Parameter (group)	Uncertainty parameter	Value
Aflatoxins LFGB ASU L 15.00-2 mod, VDLUFA III, 16.1.4 mod.	Reproducibility standard deviation sR	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel
Antioxidants inhouse method	Reproducibility standard deviation sR	± 5 % rel
	Expanded measurement uncertainty U	± 10 % rel
Beta-/gamma-amylase activity inhouse method	Reproducibility standard deviation *sR*	± 25 % (at 5 U/kg)
	Expanded measurement uncertainty U	± 4 U/kg (range 2 to 10 U/kg)
Beta-fructofuranosidase activity inhouse method	Reproducibility standard deviation *sR*	± 4 % at 100 U/kg(equals 5 % addition of sugar syrup)
	Expanded measurement uncertainty U	± 11 % (at 20 U/kg) ± 10 % (at 100 U/kg)
Deoxynivalenol (DON) DIN EN 15891	Reproducibility standard deviation sR	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel
DHA, MGO inhouse method	Reproducibility standard deviation sR	± 7.5 % rel
	Expanded measurement uncertainty U	± 15 % rel
10-HDA (royal jelly) inhouse method	Reproducibility standard deviation *sR*	± 2.5 % (fresh RJ)
	Expanded measurement uncertainty U	± 5.0 % (fresh RJ)

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
HMF (honey) DIN 10751-3	Reproducibility standard deviation *sR*	± 2.5 % rel
	Expanded measurement uncertainty U	± 5 % rel
Methyl anthranilate inhouse method	Reproducibility standard deviation *sR*	± 5 %
	Expanded measurement uncertainty U	± 10 %
Naphthalene inhouse method	Reproducibility standard deviation sR	± 6 % rel
	Expanded measurement uncertainty U	± 12 % rel
Na-Cyclamate LFGB ASU L 00.00-29	Reproducibility standard deviation sR	± 10 % rel
	Expanded measurement uncertainty U	± 20 % rel
Non-honey oligosaccharides inhouse method	Reproducibility standard deviation *sR*	± 0.11 % at 0.56 %
	Expanded measurement uncertainty U	± 0.22 % at 0.56 %
Ochratoxin inhouse method	Reproducibility standard deviation sR	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel
Patulin LFGB ASU L 31.00-20 mod.	Reproducibility standard deviation sR	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel
Phenol, Thymol inhouse method	Reproducibility standard deviation sR	± 10 % rel
	Expanded measurement uncertainty U	± 20 % rel
Polyphenols inhouse method	Reproducibility standard deviation sR	± 10 % rel
	Expanded measurement uncertainty U	± 20 % rel
Preservatives LFGB ASU L 00.00-9 mod.	Reproducibility standard deviation sR	± 7.5 % rel
	Expanded measurement uncertainty U	± 15 % rel
Sugar spectrum (honey) DIN 10758	Reproducibility standard deviation *sR*	Glucose: ± 3 % rel Fructose: ± 2.5 % rel
	Expanded measurement uncertainty U	Glucose: ± 6 % rel Fructose: ± 5 % rel
Sweeteners LFGB ASU L 00.00-28	Reproducibility standard deviation sR	± 5 % rel
	Expanded measurement uncertainty U	± 10 % rel
Theobromine, Caffeine inhouse method	Reproducibility standard deviation sR	± 7.5 % rel
	Expanded measurement uncertainty U	± 15 % rel
Vitamin C inhouse method	Reproducibility standard deviation sR	± 5 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
	Expanded measurement uncertainty U	± 10 % rel
Zearalenone inhouse method	Reproducibility standard deviation sR	± 15 % rel
	Expanded measurement uncertainty U	± 30 % rel

IC methods

Nitrate, Nitrite inhouse method	Reproducibility standard deviation sR	Nitrate: ± 2.9 % rel Nitrite: ± 7.4 % rel
	Expanded measurement uncertainty U	Nitrate: ± 5.8 % rel Nitrite: ± 14.8 % rel
Organic Acids inhouse method	Reproducibility standard deviation sR	Citrate: ± 5.2 % rel
	Expanded measurement uncertainty U	Citrate: ± 10.4 % rel
Sugars inhouse method	Reproducibility standard deviation sR	Glucose: ± 7.8 % rel Fructose: ± 9.2 % rel Sucrose: ± 6.1 % rel Mannose: ± 11.5 % rel
	Expanded measurement uncertainty U	Glucose: ± 15.6 % rel Fructose: ± 18.4 % rel Sucrose: ± 12.2 % rel Mannose: ± 23.0 % rel
Sugar alcohols (Alditoles) inhouse method	Reproducibility standard deviation sR	Sorbitol: ± 11.5 % rel
	Expanded measurement uncertainty U	Sorbitol: ± 23.0 % rel

ICP-MS methods

Parameter (group)	Uncertainty parameter	Value
Arsenic species inhouse method	Reproducibility standard deviation s_R	± 10%
	Expanded measurement uncertainty U	± 20%
Bromine, Iodine inhouse method	Reproducibility standard deviation s_R	± 5%
	Expanded measurement uncertainty U	± 10%
Elements, general DIN EN 15763, DIN EN ISO 17294-2:	Reproducibility standard deviation s_R	± 5%
	Expanded measurement uncertainty U	± 10%
TM-R inhouse method	Reproducibility standard deviation s_R	± 5%
	Expanded measurement uncertainty U	± 10%

LC-MS/MS, GC-MS/MS methods

Performance Parameters, Measurement Uncertainties, Decision Rules

Remark: Variation depends on matrix (honey, royal jelly, pollen etc.) as well as the detected analyte (antibiotic) and can only be estimated within a broad range.

Parameter (group)	**Uncertainty parameter**	**Value**
Aminoglycosides inhouse method	Reproducibility standard deviation *sR*	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Amphenicols inhouse method	Reproducibility standard deviation *sR*	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Beta-Lactam Antibiotics inhouse method	Reproducibility standard deviation *sR*	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Fluoroquinolones inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Macrolides inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Nitrofuran metabolites inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Nitroimidazoles inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Polycyclic aromatic hydrocarbons (PAHs) inhouse method	Reproducibility standard deviation *sR*	± 5.0 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 10.0 % (min) – 50.0 % (max)
Polychlorinated biphenyls (PCB) LFGB ASU L00.00-115:2014-02	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7.0 % (min) – 50.0 % (max)
Pyrrolizidine alkaloids inhouse method	Reproducibility standard deviation *sR*	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Streptomycin inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Sulfonamides inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Tetracyclines inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)

Performance Parameters, Measurement Uncertainties, Decision Rules

Parameter (group)	Uncertainty parameter	Value
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
SM-R inhouse method	Reproducibility standard deviation sR	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Tropane alkaloids inhouse method	Reproducibility standard deviation *sR*	± 3.5 % (min) – 25.0 % (max)
	Expanded measurement uncertainty U	± 7 % (min) – 50.0 % (max)
Pesticides (LC-MS/MS and GC-MS/MS)	Reproducibility standard deviation sR	± 25.0 % rel
LFGB L 00.00-115, EURL-SRM QuPPe, etc.	Expanded measurement uncertainty U	± 50.0 % rel

NMR methods

Parameter (group)	Uncertainty parameter	Value
Methylcafestol inhouse method	Reproducibility standard deviation *sR*	± 10.0 % rel
	Expanded measurement uncertainty U	± 20.0 % rel

Pollen Analysis (Microscopy, etc.), DIN 10760

Parameter (group)	Uncertainty parameter	Value
Cruciferae (for 500 counted pollen grains)	Reproducibility standard deviation *sR*	± 3.68 % rel
	Expanded measurement uncertainty U	± 7.36 % rel
Rosaceae (for 500 counted pollen grains)	Reproducibility standard deviation *sR*	± 2.58 % rel
	Expanded measurement uncertainty U	± 5.16 % rel
Acer (for 500 counted pollen grains)	Reproducibility standard deviation *sR*	± 3.22 % rel
	Expanded measurement uncertainty U	± 6.44 % rel
all clover types (for 500 counted pollen grains)	Reproducibility standard deviation *sR*	± 1.33 % rel
	Expanded measurement uncertainty U	± 2.66 % rel

Performance Parameters, Measurement Uncertainties, Decision Rules

Links and further reading	1. Codex Alimentarius: GUIDELINES ON MEASUREMENT UNCERTAINTY CAC/GL 54-2004, free download from http://www.codexalimentarius.net and a Draft Annex from ftp://ftp.fao.org/**codex**/Circular_Letters/CXCL2010/cl10_49e.pdf 2. EURACHEM/CITAC Guide CG 4 on Quantifying Uncertainty In Analytical Measurement (Third Edition), EURACHEM Secretariat, BAM, Berlin, 2000, free download from https://www.eurachem.org/index.php/publications/guides/quam or directly https://www.eurachem.org/images/stories/Guides/pdf/QUAM2012_P1.pdf 3. HARMONISED METHODS OF THE INTERNATIONAL HONEY COMMISSION, free download from http://www.ihc-platform.net/ihcmethods2009.pdf 4. Canadian Association for Laboratory Accreditation Inc. (CALA) : Measurement Uncertainty Policy 19 : from http://www.cala.ca/P19_CALA_Unce_Pol.pdf 5. ILAC Guide 17: Introducing the Concept of Uncertainty of Measurement in Testing in Association with the Application of the Standard ISO/IEC 17025 from https://ilac.org/publications-and-resources/ilac-guidance-series/

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