

Institute for
Interlaboratory Studies

**Results of Proficiency Test
Preservatives in Skin Care products
(CMIT/MIT &
Parabens/Phenoxyethanol &
Benzoic Acid/Formaldehyde)
November 2023**

Organized by: Institute for Interlaboratory Studies
Spijkenisse, the Netherlands

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1 INTRODUCTION

Preservatives may be used in cosmetics to prevent the growth of harmful bacteria and mold. Chloromethylisothiazolinone (CMIT) and Methylisothiazolinone (MIT), Parabens, Phenoxyethanol, Formaldehyde and Benzoic Acid are widely used as preservatives in liquid cosmetic and personal care products.

CMIT and MIT could be allergenic and cytotoxic, while Parabens and Phenoxyethanol are linked to hormonal disruption. Benzoic Acid is suspect for being the simplest aromatic carboxylic acid.

These preservatives in skin care products are regulated through Annex V of Regulation (EC) No 1223/2009 ("Cosmetics Regulation").

Since 2018 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for the determination of CMIT (5-Chloro-2-Methyl-4-Isothiazolin-3-one) and MIT (2-Methyl-4-Isothiazolin-3-one) in Skin Care Products and for Parabens and other preservatives since 2019. During the annual testing program of 2023 it was decided to continue the proficiency test for the determination of Preservatives in Skin Care Products. It was decided to conduct three different proficiency tests (PTs) of Preservatives in Skin Care Products: the PT CMIT/MIT, the PT Parabens/Phenoxyethanol and the PT Benzoic Acid/Formaldehyde.

In this interlaboratory study registered for participation:

- 9 laboratories in 8 countries for CMIT/MIT in Skin Care products iis23H72A
- 12 laboratories in 10 countries for Parabens/Phenoxyethanol in Skin Care products iis23H72B
- 8 laboratories in 7 countries for Benzoic Acid/Formaldehyde in Skin Care products iis23H72C

In total 17 laboratories in 13 countries registered for participation, see appendix 3 for the number of participants per country. In this report the results of the Preservatives in Skin Care products proficiency test are presented and discussed. This report is also electronically available through the iis website www.iisnl.com.

2 SET UP

The Institute for Interlaboratory Studies (iis) in Spijkenisse, the Netherlands, was the organizer of this proficiency test (PT). Sample analyzes for fit-for-use and homogeneity testing were subcontracted to a laboratory that has performed the tests in accordance with for ISO/IEC17043 relevant requirements of ISO/IEC17025.

In this proficiency test the participants received, depending on the registration, from one up to three different Skin Care products, see table below.

Sample ID	PT and product type	Quantity
#23775	CMIT/MIT in Night Cream iis23H72A	1x 3 grams
#23780	Parabens/Phenoxyethanol in Aftersun iis23H72B	1x 10 mL
#23785	Benzoic Acid/Formaldehyde in Body Lotion iis23H72C	1x 3 grams

Table 1: samples used in PT iis23H72

The participants were requested to report rounded and unrounded test results. The unrounded test results were preferably used for statistical evaluation.

2.1 QUALITY SYSTEM

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, has implemented a quality system based on ISO/IEC17043:2010. This ensures strict adherence to protocols for sample preparation and statistical evaluation and 100% confidentiality of participant's data. Feedback from the participants on the reported data is encouraged and customer's satisfaction is measured on regular basis by sending out questionnaires.

2.2 PROTOCOL

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5). This protocol is electronically available through the iis website www.iisnl.com, from the FAQ page.

2.3 CONFIDENTIALITY STATEMENT

All data presented in this report must be regarded as confidential and for use by the participating companies only. Disclosure of the information in this report is only allowed by means of the entire report. Use of the contents of this report for third parties is only allowed by written permission of the Institute for Interlaboratory Studies. Disclosure of the identity of one or more of the participating companies will be done only after receipt of a written agreement of the companies involved.

2.4 SAMPLES

For the PT CMIT/MIT in Skin care products a batch of night cream was purchased from a local supermarket and was artificially fortified with CMIT/MIT. After homogenization 20 PE bottles of 10 mL were filled and labelled #23775.

The homogeneity of the subsamples was checked by determination of CMIT and MIT using an in-house test method on 5 stratified randomly selected subsamples.

	CMIT in mg/kg	MIT in mg/kg
sample #23775-1	22.91	9.27
sample #23775-2	22.24	9.55
sample #23775-3	22.13	8.66
sample #23775-4	22.93	8.94
sample #23775-5	23.61	9.07

Table 2: homogeneity test results of subsamples #23775

From the above test results the repeatabilities were calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	CMIT in mg/kg	MIT in mg/kg
r (observed)	1.68	0.94
reference method	Horwitz	Horwitz
0.3 x R (reference method)	1.91	0.88

Table 3: evaluation of the repeatabilities of subsamples #23775

The calculated repeatabilities are in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

For the PT parabens/Phenoxyethanol in Skin Care products a batch of aftersun was purchased from a local supermarket and was artificially fortified with the preservatives Methylparaben, Ethylparaben, Propylparaben, Isobutylparaben, Butylparaben and Phenoxyethanol. After homogenization 30 PE bottles of 10 mL were filled and labelled #23780.

The homogeneity of the subsamples was checked by determination of Methylparaben and Isobutylparaben by using an in-house test method on 5 stratified randomly selected subsamples.

	Methylparaben in mg/kg	Isobutylparaben in mg/kg
sample #23780-1	435.1	171.6
sample #23780-2	446.0	174.2
sample #23780-3	429.9	171.2
sample #23780-4	422.4	172.6
sample #23780-5	430.0	175.0

Table 4: homogeneity test results of subsamples #23780

From the above test results the repeatabilities were calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Methylparaben in mg/kg	Isobutylparaben in mg/kg
r (observed)	24.5	4.6
reference method	Horwitz	Horwitz
0.3 x R (reference method)	23.3	10.7

Table 5: evaluation of the repeatabilities of subsamples #23780

The calculated repeatabilities are in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

For the PT Bezoic Acid/Formaldehyde in Skin Care products a batch of body lotion was purchased from a local supermarket and was artificially fortified with Benzoic Acid, 4-Hydroxybenzoic acid and Formaldehyde. After homogenization 25 PE bottles of 10 mL were filled and labelled #23780.

The homogeneity of the subsamples was checked by determination of Benzoic Acid and 4-Hydroxybenzoic acid by using an in-house test method on 4 stratified randomly selected subsamples.

	Benzoic Acid in mg/kg	4-Hydroxybenzoic acid in mg/kg
sample #23785-1	2519	2303
sample #23785-2	2477	2271
sample #23785-3	2502	2248
sample #23785-4	2490	2326

Table 6: homogeneity test results of subsamples #23785

From the above test results the repeatabilities were calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Benzoic Acid in mg/kg	4-Hydroxybenzoic acid in mg/kg
r (observed)	50	96
reference method	Horwitz	Horwitz
0.3 x R (reference method)	103	96

Table 7: evaluation of the repeatabilities of subsamples #23785

The calculated repeatabilities are in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

Depending on the registration of the participant the appropriate set of PT samples was sent on November 1, 2023.

2.5 ANALYZES

The participants were requested to determine on sample #23775 the concentrations of CMIT (5-Chloro-2-Methyl-4-Isothiazolin-3-one) and MIT (2-Methyl-4-Isothiazolin-3-one).

On sample #23780 it was requested to determine the concentrations of Methylparaben as ester, Ethylparaben as ester, Propylparaben as ester, Isobutylparaben as ester, Butylparaben as ester and Phenoxyethanol.

On sample #23785 it was requested to determine the concentrations of 4-Hydroxybenzoic acid, Benzoic acid and Formaldehyde.

It was also requested to report if the laboratory was accredited for the determined components and to report the amount of sample intake.

It was explicitly requested to treat the samples as if they were routine samples and to report the test results using the indicated units on the report form and not to round the test results, but report as much significant figures as possible. It was also requested not to report 'less than' test results, which are above the detection limit, because such test results cannot be used for meaningful statistical evaluations.

To get comparable test results a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the reference test methods (when applicable) that will be used during the evaluation. The detailed report form and the letter of instructions are both made available on the data entry portal www.kpmd.co.uk/sgs-iis-cts/. The participating laboratories are also requested to confirm the sample receipt on this data entry portal. The letter of instructions can also be downloaded from the iis website www.iisnl.com.

3 RESULTS

During five weeks after sample dispatch, the test results of the individual laboratories were gathered via the data entry portal www.kpmd.co.uk/sgs-iis-cts/. The reported test results are tabulated per determination in appendix 1 of this report. The laboratories are presented by their code numbers.

Directly after the deadline, a reminder was sent to those laboratories that had not reported test results at that moment. Shortly after the deadline, the available test results were screened for suspect data. A test result was called suspect in case the Huber Elimination Rule (a robust outlier test) found it to be an outlier. The laboratories that produced these suspect data were asked to check the reported test results (no reanalyzes). Additional or corrected test results are used for data analysis and the original test results are placed under 'Remarks' in the result tables in appendix 1. Test results that came in after the deadline were not taken into account in this screening for suspect data and thus these participants were not requested for checks.

3.1 STATISTICS

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5).

For the statistical evaluation the *unrounded* (when available) figures were used instead of the rounded test results. Test results reported as '<... ' or '>... ' were not used in the statistical evaluation.

First, the normality of the distribution of the various data sets per determination was checked by means of the Lilliefors-test, a variant of the Kolmogorov-Smirnov test and by the calculation of skewness and kurtosis. Evaluation of the three normality indicators in combination with the visual evaluation of the graphic Kernel density plot, lead to judgement of the normality being either 'unknown', 'OK', 'suspect' or 'not OK'. After removal of outliers, this check was repeated. If a dataset does not have a normal distribution, the (results of the) statistical evaluation should be used with due care.

The assigned value is determined by consensus based on the test results of the group of participants after rejection of the statistical outliers and/or suspect data.

According to ISO13528 all (original received or corrected) results per determination were submitted to outlier tests. In the iis procedure for proficiency tests, outliers are detected prior to calculation of the mean, standard deviation and reproducibility. For small data sets, Dixon (up to 20 test results) or Grubbs (up to 40 test results) outlier tests can be used. For larger data sets (above 20 test results) Rosner's outlier test can be used. Outliers are marked by $D(0.01)$ for the Dixon's test, by $G(0.01)$ or $DG(0.01)$ for the Grubbs' test and by $R(0.01)$ for the Rosner's test. Stragglers are marked by $D(0.05)$ for the Dixon's test, by $G(0.05)$ or $DG(0.05)$ for the Grubbs' test and by $R(0.05)$ for the Rosner's test. Both outliers and stragglers were not included in the calculations of averages and standard deviations.

For each assigned value the uncertainty was determined in accordance with ISO13528. Subsequently the calculated uncertainty was evaluated against the respective requirement based on the target reproducibility in accordance with ISO13528. In this PT, the criterion of ISO13528, paragraph 9.2.1 was met for all evaluated tests, therefore, the uncertainty of all assigned values may be negligible and need not be included in the PT report.

Finally, the reproducibilities were calculated from the standard deviations by multiplying them with a factor of 2.8.

3.2 GRAPHICS

In order to visualize the data against the reproducibilities from literature, Gauss plots were made, using the sorted data for one determination (see appendix 1). On the Y-axis the reported test results are plotted. The corresponding laboratory numbers are on the X-axis. The straight horizontal line presents the consensus value (a trimmed mean). The four striped lines, parallel to the consensus value line, are the +3s, +2s, -2s and -3s target reproducibility limits of the selected reference test method. Outliers and other data, which were excluded from the calculations, are represented as a cross. Accepted data are represented as a triangle.

Furthermore, Kernel Density Graphs were made. This is a method for producing a smooth density approximation to a set of data that avoids some problems associated with histograms. Also, a normal Gauss curve (dotted line) was projected over the Kernel Density Graph (smooth line) for reference. The Gauss curve is calculated from the consensus value and the corresponding standard deviation.

3.3 Z-SCORES

To evaluate the performance of the participating laboratories the z-scores were calculated. As it was decided to evaluate the performance of the participants in this proficiency test (PT) against the literature requirements (derived from e.g. ISO or ASTM test methods), the z-scores were calculated using a target standard deviation. This results in an evaluation independent of the variation in this interlaboratory study.

The target standard deviation was calculated from the literature reproducibility by division with 2.8. In case no literature reproducibility was available, other target values were used, like Horwitz or an estimated reproducibility based on former iis proficiency tests.

When a laboratory did use a test method with a reproducibility that is significantly different from the reproducibility of the reference test method used in this report, it is strongly advised to recalculate the z-score, while using the reproducibility of the actual test method used, this in order to evaluate whether the reported test result is fit-for-use.

The z-scores were calculated according to:

$$z_{(\text{target})} = (\text{test result} - \text{average of PT}) / \text{target standard deviation}$$

The $z_{(\text{target})}$ scores are listed in the test result tables in appendix 1.

Absolute values for $z < 2$ are very common and absolute values for $z > 3$ are very rare. Therefore, the usual interpretation of z-scores is as follows:

	$ z < 1$	good
1 <	$ z < 2$	satisfactory
2 <	$ z < 3$	questionable
3 <	$ z $	unsatisfactory

4 EVALUATION

In this proficiency test no problems were encountered with the dispatch of the samples. For the PT CMIT/MIT in Skin Care products and for the PT Benzoic Acid/Formaldehyde in Skin Care products reported all participants the test results before the final reporting date. For the PT Parabens/Phenoxyethanol one participants did not report any test result. Not all participants were able to report all test results requested. In total 16 participants reported 80 numerical test results. Observed was 1 outlying test result, which is 1.3%. In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

Not all data sets proved to have a normal Gaussian distribution. These are referred to as “not OK” or “suspect”. The statistical evaluation of these data sets should be used with due care, see also paragraph 3.1.

4.1 EVALUATION PER SAMPLE AND PER COMPONENT

In this section the reported test results are discussed per sample and per component. The test methods which were used by the various laboratories were taken into account for explaining the observed differences when possible and applicable. These test methods are also in the tables together with the original data in appendix 1. The abbreviations, used in these tables, are explained in appendix 4.

Unfortunately, a suitable reference test method providing the precision data is not available for all determinations. For these tests the calculated reproducibility was compared against the estimated reproducibility calculated with the Horwitz equation.

sample #23775

CMIT: The group of participants met the target requirements. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the estimated reproducibility calculated with the Horwitz equation.

MIT: The group of participants may have had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

sample #23780

Methylparaben: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the estimated reproducibility calculated with the Horwitz equation.

Ethylparaben: The group of participants may have had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

Propylparaben: The group of participants may have had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

Isobutylparaben: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the estimated reproducibility calculated with the Horwitz equation.

Butylparaben: The group of participants may have had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

Phenoxyethanol: The group of participants may have had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

sample #23785

4-Hydroxybenzoic acid: Only two participants reported a test result. Therefore, no z-scores are calculated.

Benzoic acid: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the estimated reproducibility calculated with the Horwitz equation.

Formaldehyde: Only a few participants reported a numeric test result. Therefore, no z-scores are calculated.

4.2 PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the reference method and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average, the calculated reproducibility ($2.8 \cdot$ standard deviation) and the target reproducibility derived from the reference method are presented in the next tables.

Component	unit	n	average	2.8 * sd	R(target)
CMIT	mg/kg	7	32.8	8.4	8.7
MIT	mg/kg	9	11.9	6.0	3.7

Table 8: reproducibilities of tests on sample #23775

Component	unit	n	average	2.8 * sd	R(target)
Methylparaben	mg/kg	9	593	106	102
Ethylparaben	mg/kg	10	197	78	40
Propylparaben	mg/kg	10	202	78	41
Isobutylparaben	mg/kg	6	273	50	53
Butylparaben	mg/kg	9	169	62	35
Phenoxyethanol	mg/kg	7	13497	4029	1445

Table 9: reproducibilities of tests on sample #23780

Component	unit	n	average	2.8 * sd	R(target)
4-Hydroxybenzoic acid	mg/kg	2	4041	n.e.	n.e.
Benzoic acid	mg/kg	7	3716	493	483
Formaldehyde	mg/kg	5	<10	n.e.	n.e.

Table 10: reproducibilities of tests on sample #23785

Without further statistical calculations it can be concluded that for many tests there is not a good compliance of the group of participating laboratories with the target reproducibility. The problematic tests have been discussed in paragraph 4.1.

4.3 COMPARISON OF THE PROFICIENCY TEST OF NOVEMBER 2023 WITH PREVIOUS PTS

	November 2023	November 2022	November 2021	November 2020	November 2019*)
Number of reporting laboratories	16	12	16	16	13 / 13
Number of test results	80	63	95	82	26 / 67
Number of statistical outliers	1	3	7	8	0 / 3
Percentage of statistical outliers	1.3%	4.8%	7.4%	9.8%	0% / 4.5%

Table 11: comparison with previous proficiency tests

*) PT for CMIT/MIT / PT for Preservatives in Skin Care separately

In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

The performance of the determinations of the proficiency test was compared to uncertainties observed in PTs over the years, expressed as relative standard deviation (RSD) of the PTS, see next table.

Component	November 2023	November 2022	November 2021	November 2020	2019 -2018
CMIT	9%	7%	11%	8%	10-20%
MIT	18%	12%	12%	10%	19%
Methylparaben	6%	---	6%	6%	13%
Ethylparaben	14%	9%	---	7%	11%
Propylparaben	14%	15%	6%	5%	12%
Isobutylparaben	6%	7%	7%	14%	14%
Butylparaben	13%	---	14%	3%	7%
Phenoxyethanol	11%	7%	4%	8%	12%
4-Hydroxybenzoic acid	---	---	---	---	---
Benzoic acid	5%	6%	7%	---	---
Formaldehyde	---	---	---	---	---

Table 12: development of the uncertainties over the years

The uncertainties observed in this PT are comparable to the uncertainties observed in previous PTs.

4.4 EVALUATION OF THE ANALYTICAL DETAILS

For this PT some analytical details were requested which are listed in appendix 2. Based on the answers given by the participants the following can be summarized:

- For the determination of CMIT/MIT four participants mentioned that they are accredited for this determination. Two participants used 0.5 gram or less for sample intake and six others used a sample intake of 2 grams or more.
- For the determination of Parabens/Phenoxyethanol eight participants mentioned that they are accredited for this determination. For Parabens seven participants used 1 gram or less for sample intake and two others used a sample intake of 2 grams or more. For Phenoxyethanol six participants used 1 gram or less for sample intake and one other participant used a sample intake of 5 grams.
- For the determination of Benzoic Acid/Formaldehyde six participants mentioned that they are accredited for this determination. For Benzoic Acid four participants used 0.6 gram or less for sample intake and two others used a sample intake of 1 gram or more. For Formaldehyde three participants used 0.6 gram or less for sample intake and two others used a sample intake of 1 gram or more.

The influence of these analytical details could not be determined because the group of participants is too small for further sub analyzes.

5 DISCUSSION

Most of the participants were able to detect CMIT/MIT and several other Preservatives in this proficiency test. Limits for the presence Preservatives in Skin Care Products have been set through Annex V of Regulation (EC) No 1223/2009 ("Cosmetics Regulation") from 30-11-2009 and last updated on 01-12-2023.

Component	Rinse-off product	Leave-on product
CMIT:MIT 3:1	15 mg/kg (0.0015%)	shall not contain
MIT	15 mg/kg (0.0015%)	shall not contain

Table 13: limits for CMIT/MIT in Commission Regulation (EU) 1223/2009, Annex V, entry 39 and 57 respectively

Note from Annex V: the use of the mixture is incompatible with the use of MIT alone in the same product

Sample #23775 is a night cream and thus a leave-on product. Since the use of CMIT/MIT in Annex V is only specified for rinse-off products, it is stated in article 14d of the same regulation that if used for anything other than rinse-off, it should not contain CMIT/MIT. All reporting participants would have rejected sample #23775 because of the detected presence of CMIT/MIT in the sample.

It is observed that almost all reporting participants would reject sample #23780 for the presence of Isobutylparaben and/or level of Phenoxyethanol above the limit in accordance with the Annex V of Regulation (EC) No 1223/2009. Remarkably, two participants only reported test results for Methylparaben, Ethylparaben, Propylparaben or Butylparaben and may have accepted this sample based on only these determinations.

Components	Limit in mg/kg
Isobutylparaben (Annex II, entry 1375)	prohibited
Methylparaben, Ethylparaben and 4-Hydroxybenzoic Acid (Annex V, entry 12) - for single ester - for mixtures of esters	4000 (0.4%) 8000 (0.8%)
Propylparaben and Butylparaben (Annex V, entry 12a) - sum of individual concentrations - mixtures entry 12 and 12a	1400 (0.14%) 8000 (0.8%)
Phenoxyethanol (Annex V, entry 29)	10000 (1%)
Formaldehyde (Annex II, entry 1577)	prohibited
Benzoic acid (Annex V, entry 1) - leave-on products - rinse-off products	5000 (0.5%) 25000 (2.5%)

Table 14: limits for Preservatives in Commission Regulation (EU) 1223/2009

One reporting participant would accept sample #23785 and one other reporting participant would reject the sample for the presence of 4-Hydroxybenzoic Acid in accordance with Annex V of Regulation (EC) No 1223/2009.

All reporting participants would accept the sample for the presence of Benzoic acid.

Some reporting participants would reject sample #23785 for the presence of Formaldehyde, because this component is included in the list of prohibited substances in Commission Regulation (EC) No 1223/2009.

In this PT, the average of the homogeneity test results are not in line with the average (consensus value) from the PT results. There are several reasons for this. First, the goal of the homogeneity testing is very different from the goal of the evaluation of the reported PT results. In order to prove the homogeneity of the PT samples, a test method is selected with a high precision (smallest variation). The accuracy (trueness) of the test method is less relevant.

Secondly, the homogeneity testing is done by one laboratory only. The test results of this (ISO/IEC 17025 accredited) laboratory will have a bias (systematic deviation) depending on the test method used. The desire to detect small variations between the PT samples leads to the use of a sensitive test method with high precision, which may be a test method with significant bias.

Also each test result reported by the laboratories that participate in the PT will have a bias. However, some will have a positive bias and others a negative bias. These different biases compensate each other in the PT average (consensus value). Therefore, the PT consensus value may deviate from the average of the homogeneity test. At the same time the accuracy of the PT consensus value is more reliable than the accuracy of the average of the results of the homogeneity test.

6 CONCLUSION

No reference materials for CMIT or MIT and for individual Parabens in cosmetics are available to optimise the determination of CMIT/MIT, Parabens/Phenoxyethanol or Benzoic Acid/Formaldehyde. As an alternative, participation in a proficiency test may enable the laboratories to check their performance and thus to increase this comparability.

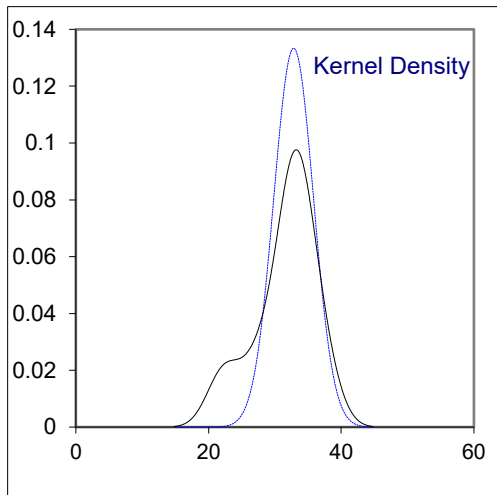
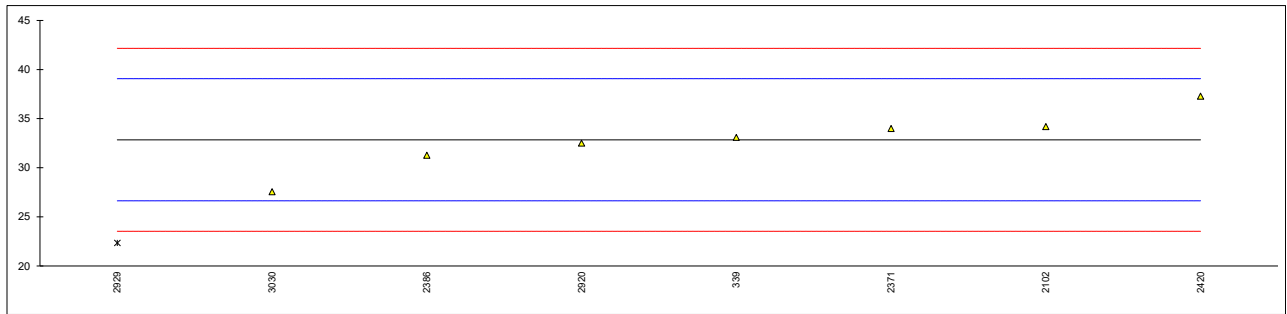
Each participating laboratory will have to evaluate its performance in this study and decide about any corrective actions if necessary. Therefore, participation on a regular basis in this scheme could be helpful to improve the performance and the quality of the analytical results.

APPENDIX 1

Determination of CMIT (5-Chloro-2-Methyl-4-Isothiazolin-3-one) CAS No. 26172-55-4 in sample #23775; results in mg/kg

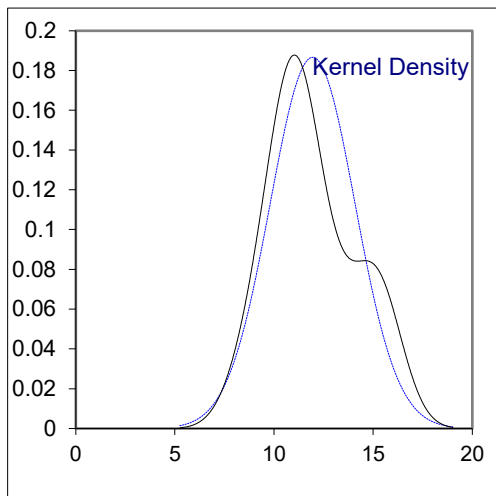
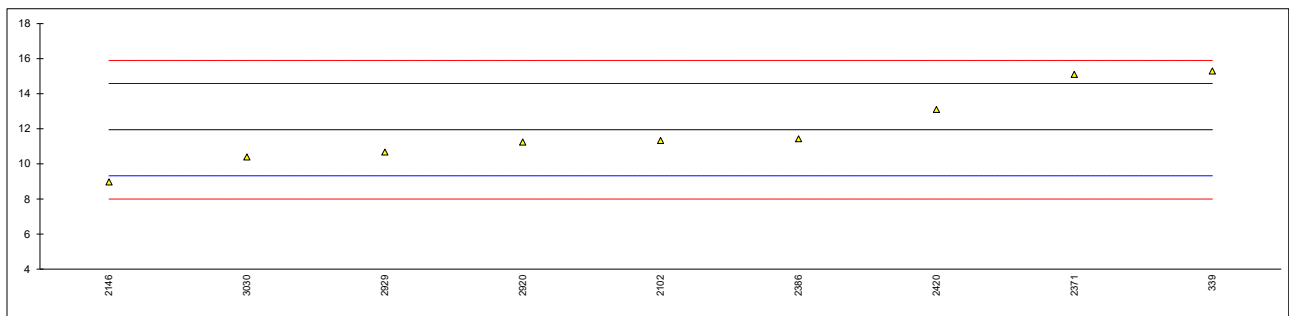
lab	method	value	mark	z(targ)	remarks
339	In house	33.1		0.08	
2102	In house	34.20		0.44	
2146		-----	W	-----	Test result withdrawn, reported 20.537
2371	In house	34.0		0.37	
2386	In house	31.265		-0.51	
2420	In house	37.3		1.43	
2920	In house	32.503		-0.11	
2929	In house	22.35	G(0.05)	-3.38	
3030	In house	27.548		-1.70	

normality unknown
n 7
outliers 1
mean (n) 32.8451
st.dev. (n) 2.99315 RSD=9%
R(calc.) 8.3808
st.dev.(Horwitz) 3.10699
R(Horwitz) 8.6996



Determination of MIT (2-Methyl-4-Isothiazolin-3-one) CAS No. 2682-20-4 in sample #23775; results in mg/kg

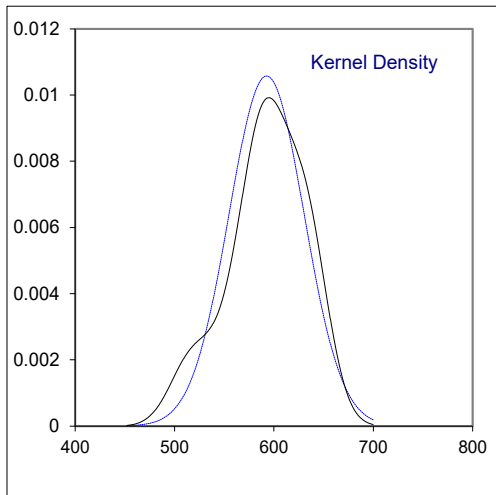
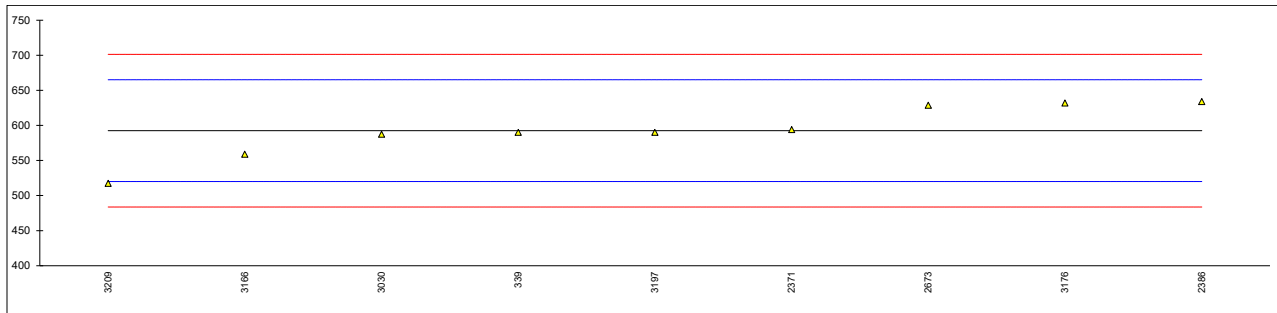
lab	method	value	mark	z(targ)	remarks
339	In house	15.3		2.55	
2102	In house	11.33		-0.47	
2146	In house	8.973		-2.26	
2371	In house	15.1		2.39	
2386	In house	11.433		-0.39	
2420	In house	13.1		0.87	
2920	In house	11.241		-0.54	
2929	In house	10.67		-0.97	
3030	In house	10.394		-1.18	
normality		OK			
n		9			
outliers		0			
mean (n)		11.9490			
st.dev. (n)		2.13729 RSD=18%			
R(calc.)		5.9844			
st.dev.(Horwitz)		1.31612			
R(Horwitz)		3.6851			



Determination of Methylparaben as ester CAS No. 99-76-3 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	590		-0.07	
2146		-----	W	-----	Test result withdrawn, reported 274.301
2371	In house	594		0.04	
2386	In house	634.049		1.15	
2673	In house	628.678		1.00	
2797	In house	<100	C, f-?	<-13.58	Possibly a false negative test result?
3030	In house	587.333		-0.14	
3166	In house	559		-0.92	
3176	In house	632.060		1.09	
3197	In house	590		-0.07	
3209	STSC4.1	517.5		-2.07	
3237		-----		-----	

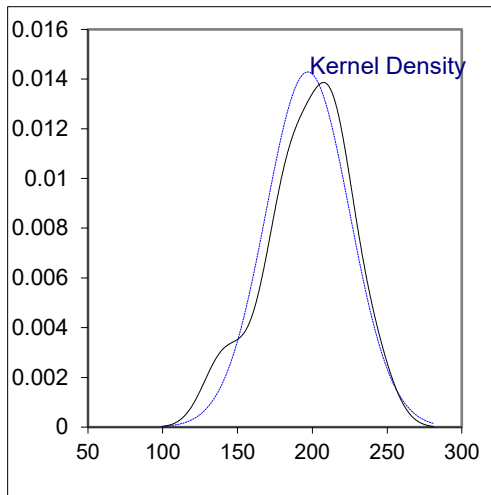
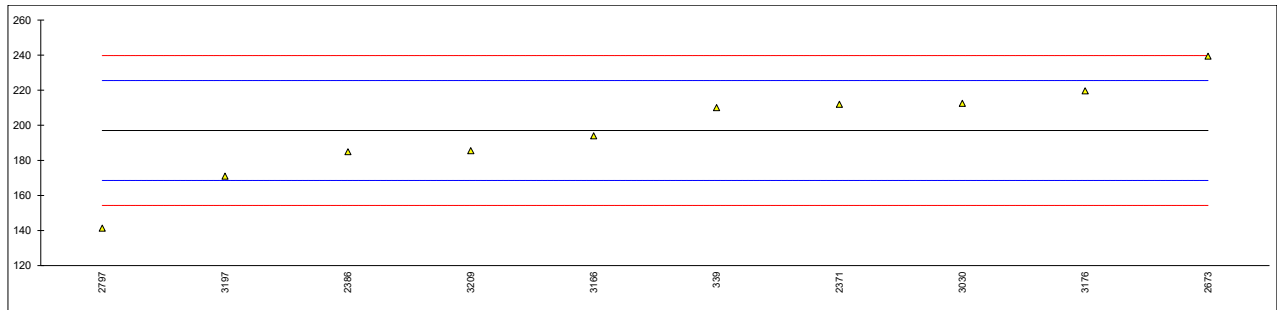
normality OK
 n 9
 outliers 0
 mean (n) 592.5133
 st.dev. (n) 37.73072 RSD=6%
 R(calc.) 105.6460
 st.dev.(Horwitz) 36.26481
 R(Horwitz) 101.5415



Determination of Ethylparaben as ester CAS No. 120-47-8 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	210		0.91	
2146		-----	W	-----	Test result withdrawn, reported 80.702
2371	In house	212		1.05	
2386	In house	184.941		-0.85	
2673	In house	239.409		2.98	
2797	In house	141.30	C	-3.92	First reported 282.59
3030	In house	212.483		1.09	
3166	In house	194		-0.21	
3176	In house	219.692		1.59	
3197	In house	171		-1.83	
3209	STSC4.1	185.5		-0.81	
3237		-----		-----	

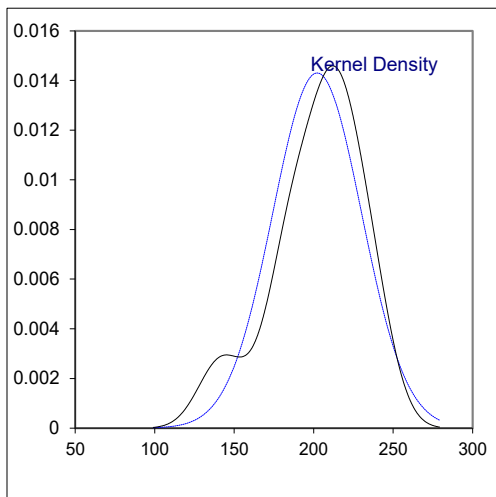
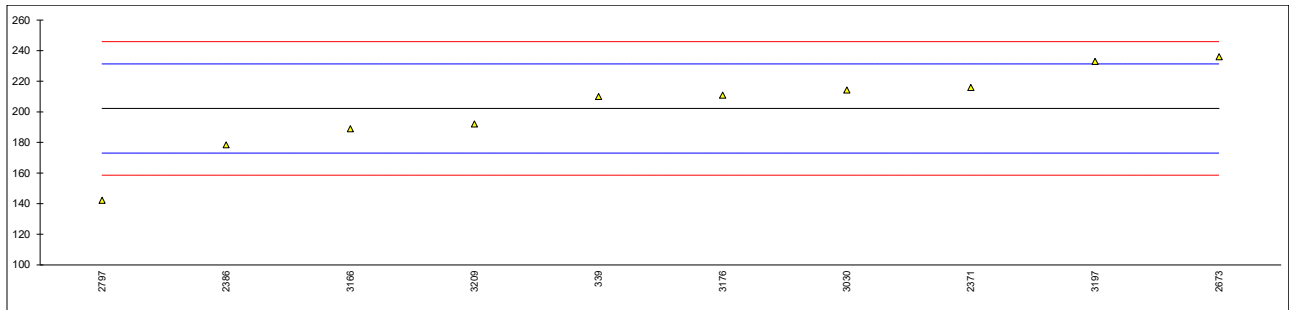
normality OK
 n 10
 outliers 0
 mean (n) 197.0325
 st.dev. (n) 27.91320 RSD=14%
 R(calc.) 78.1570
 st.dev.(Horwitz) 14.23297
 R(Horwitz) 39.8523



Determination of Propylparaben as ester CAS No. 94-13-3 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	210		0.54	
2146		-----	W	-----	Test result withdrawn, reported 83.305
2371	In house	216		0.95	
2386	In house	178.425		-1.63	
2673	In house	235.993		2.32	
2797	In house	142.22	C	-4.12	First reported 284.44
3030	In house	214.300		0.83	
3166	In house	189		-0.91	
3176	In house	210.887		0.60	
3197	In house	233		2.12	
3209	STSC4.1	192.1		-0.69	
3237		-----		-----	

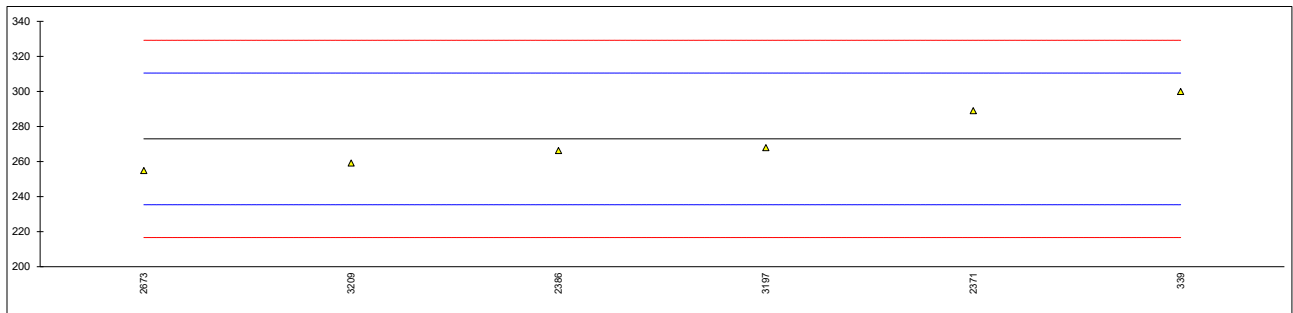
normality suspect
 n 10
 outliers 0
 mean (n) 202.1925
 st.dev. (n) 27.89436 RSD=14%
 R(calc.) 78.1042
 st.dev.(Horwitz) 14.54899
 R(Horwitz) 40.7372



Determination of Isobutylparaben as ester CAS No. 4247-02-3 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	300		1.44	
2146		-----	W	-----	Test result withdrawn, reported 95.891
2371	In house	289		0.86	
2386	In house	266.293		-0.35	
2673	In house	254.904	C	-0.96	First reported 10.081
2797	In house	-----		-----	
3030		-----		-----	
3166		-----		-----	
3176		-----		-----	
3197	In house	268		-0.26	
3209	STSC4.1	259.2		-0.73	
3237		-----		-----	

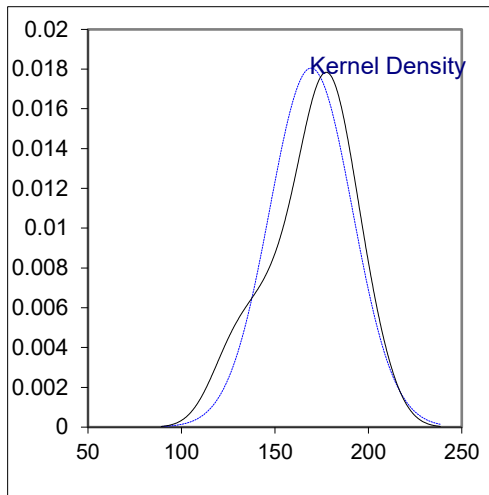
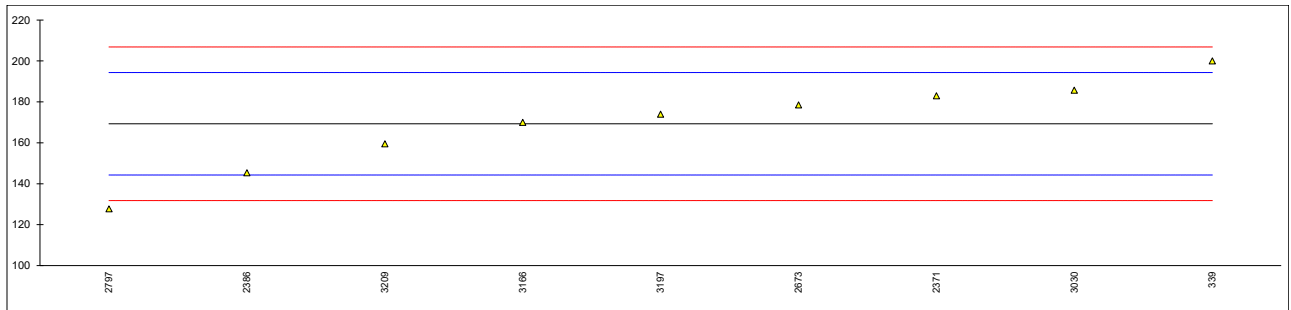
normality unknown
 n 6
 outliers 0
 mean (n) 272.8995
 st.dev. (n) 17.73600 RSD=6%
 R(calc.) 49.6608
 st.dev.(Horwitz) 18.77015
 R(Horwitz) 52.5564



Determination of Butylparaben as ester CAS No. 94-26-8 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	200		2.45	
2146		-----	W	-----	Test result withdrawn, reported 57.195
2371	In house	183		1.09	
2386	In house	145.351		-1.91	
2673	In house	178.532		0.74	
2797	In house	127.69	C	-3.33	First reported 255.39
3030	In house	185.700		1.31	
3166	In house	170		0.06	
3176		-----		-----	
3197	In house	174		0.37	
3209	STSC4.1	159.5		-0.78	
3237		-----		-----	

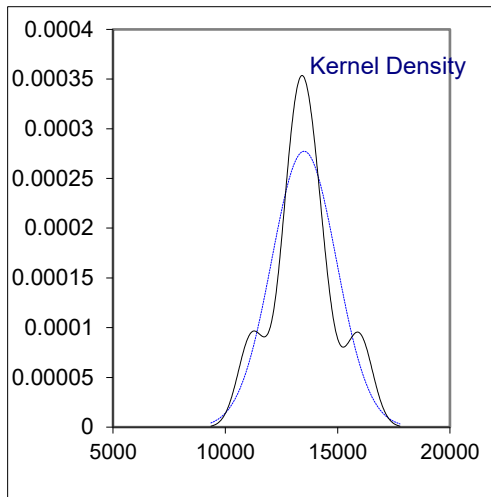
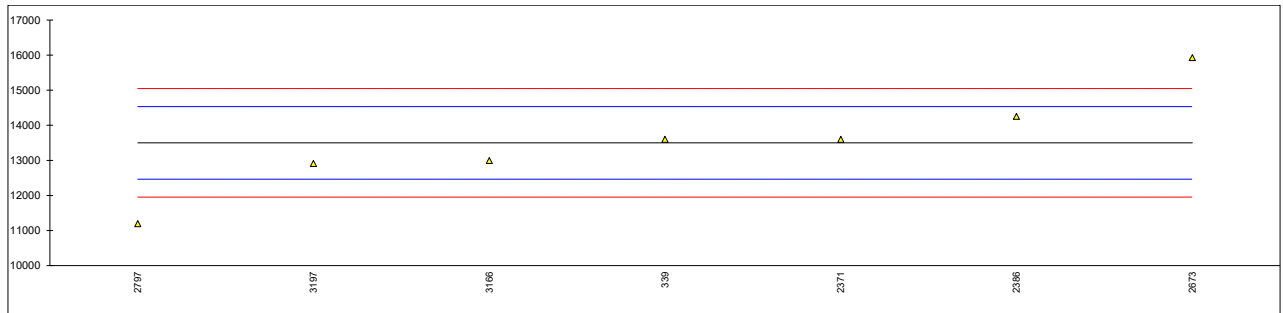
normality OK
 n 9
 outliers 0
 mean (n) 169.3081
 st.dev. (n) 22.10185 RSD=13%
 R(calc.) 61.8852
 st.dev.(Horwitz) 12.51262
 R(Horwitz) 35.0353



Determination of Phenoxyethanol CAS No. 122-99-6 in sample #23780; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	13600		0.20	
2146		-----	W	-----	Test result withdrawn, reported 6859.150
2371	In house	13600		0.20	
2386	In house	14254.92		1.47	
2673	In house	15928.750		4.71	
2797	In house	11191.48		-4.47	
3030		-----		-----	
3166	In house	12996		-0.97	
3176		-----		-----	
3197	In house	12907		-1.14	
3209		-----		-----	
3237		-----		-----	

normality unknown
 n 7
 outliers 0
 mean (n) 13496.878
 st.dev. (n) 1438.9573 RSD=11%
 R(calc.) 4029.080
 st.dev.(Horwitz) 516.0494
 R(Horwitz) 1444.938



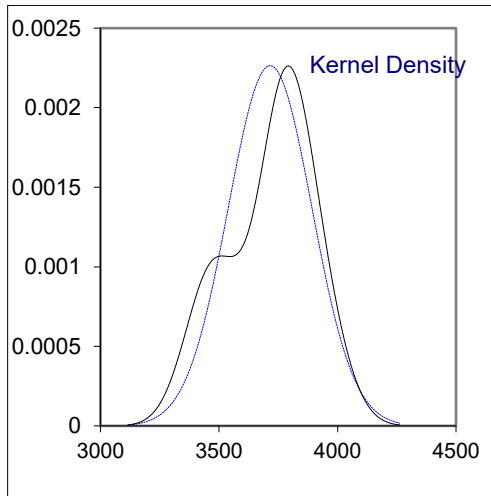
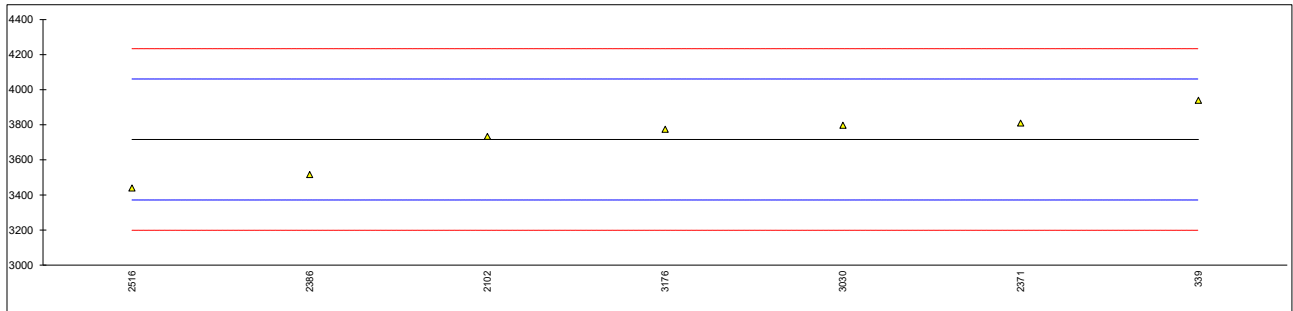
Determination of 4-Hydroxybenzoic acid in sample #23785; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339		----		----	
2102	In house	3822	C	----	First reported 0.3822 mg/kg
2371	In house	4260		----	
2386		----		----	
2516		----		----	
3030		----		----	
3176		----		----	
3197		----		----	
	n	2			
	mean (n)	4041			

Determination of Benzoic acid CAS No. 65-85-0 in sample #23785; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	3940	C	1.30	Reported 0.394 mg/kg
2102	In house	3734	C	0.11	First reported 0.3734 mg/kg
2371	In house	3810		0.55	
2386	In house	3515.75		-1.16	
2516	In house	3439		-1.60	
3030	In house	3797.80		0.48	
3176	In house	3774.04	C	0.34	First reported 351.97
3197		----		----	

normality unknown
 n 7
 outliers 0
 mean (n) 3715.7986
 st.dev. (n) 176.17448 RSD=5%
 R(calc.) 493.2886
 st.dev.(Horwitz) 172.51456
 R(Horwitz) 483.0408



Determination of Formaldehyde in sample #23785; results in mg/kg

lab	method	value	mark	z(targ)	remarks
339	In house	not detected		----	
2102	In house	Not detected		----	
2371	In house	----		----	
2386	In house	< 5		----	
2516	In house	1.9		----	
3030	In house	41.60	f+?	----	Possibly a false positive test result?
3176		----		----	
3197	In house	7.59		----	
	n	5			
	mean (n)	<10			

APPENDIX 2**Analytical details for sample #23775**

lab	Accredited acc ISO1725	Intake amount (g)
339	No	2g
2102	No	0.2 gram
2146	No	0.5 g
2371	Yes	5g
2386	Yes	2 g
2420	Yes	2g
2920	No	5 g
2929	Yes	2
3030	No	

Analytical details for sample #23780

lab	Accredited acc ISO1725	Intake amount (g)
339	No	1.5g and 0.25g for phenoxyethanol
2146	No	0.5 g
2371	Yes	5g
2386	Yes	0,4 g & 0,6 g
2673	Yes	1 g
2797	Yes	
3030	---	
3166	Yes	~0.5
3176	Yes	0,1
3197	Yes	1 g
3209	Yes	1g
3237	---	

Analytical details for sample #23785

lab	Accredited acc ISO1725	Intake amount (g)
339	No	0.25g benzoic acid 1.5g formaldehyde
2102	Yes	0.5
2371	Yes	3 g
2386	Yes	0,6 g
2516	No	0.5g
3030	Yes	
3176	Yes	1
3197	Yes	1 g

APPENDIX 3

Number of participants per country

2 labs in CROATIA
1 lab in ESTONIA
1 lab in FINLAND
1 lab in FRANCE
2 labs in GERMANY
1 lab in JAPAN
1 lab in P.R. of CHINA
1 lab in SAUDI ARABIA
1 lab in SERBIA
1 lab in TAIWAN
1 lab in THE NETHERLANDS
3 labs in TURKEY
1 lab in U.S.A.

APPENDIX 4

Abbreviations

C	= final test result after checking of first reported suspect test result
D(0.01)	= outlier in Dixon's outlier test
D(0.05)	= straggler in Dixon's outlier test
G(0.01)	= outlier in Grubbs' outlier test
G(0.05)	= straggler in Grubbs' outlier test
DG(0.01)	= outlier in Double Grubbs' outlier test
DG(0.05)	= straggler in Double Grubbs' outlier test
R(0.01)	= outlier in Rosner's outlier test
R(0.05)	= straggler in Rosner's outlier test
E	= calculation difference between reported test result and result calculated by iis
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
f+?	= possibly a false positive test result?
f-?	= possibly a false negative test result?

Literature

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- 2 ISO5725:86
- 3 ISO5725 parts 1-6:94
- 4 ISO13528:05
- 5 M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
- 6 W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
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