Measurement of the concentration of acrylamide from the 2014 UK TDS

The following technical reports will be published with this food safety information sheet. They will provide further information on the analytical method used, tabulate the analytical results and describe the sampling plan used to collect samples.

- Total Diet Study – Acrylamide Investigation: Phase 1 analysis of all group samples, Premier Analytical Services;
- Total Diet Study – Acrylamide Investigation: Phase 2 analysis of selected category samples, Premier Analytical Services;
- Sampling for UK Total Diet Study, HallMark Veterinary & Compliance Services

Introduction

Since the initial 2002 discovery of acrylamide in certain foods, research has continued internationally to improve our understanding of the toxicology, analytical methodology and formation of this contaminant as well as developing potential methods for reducing acrylamide in foods.

The Food Standards Agency (FSA) continues to fund research to better understand how and when acrylamide occurs in food.

Additional information on acrylamide can be found on the Food Standard Agency's website at:

https://www.food.gov.uk/acrylamide

The Total Diet Study

The Total Diet Study (TDS) represents the average UK diet and as such is used to estimate dietary exposure of the general UK population to a range of chemicals in food, to identify trends in exposure levels over time and make assessments on the safety and/or nutritional quality of food.

Since 2005 when the first UK TDS for acrylamide was published, the food industry has put in place a number of initiatives to reduce acrylamide levels. Therefore, it is now timely to review acrylamide levels in food and to establish a robust and up to date benchmark to underpin risk assessment in the UK. It may also provide a point of reference for future comparison.

The first UK total diet study (TDS) of levels of acrylamide in food was published in 2005. It used a combination of samples taken in 2003 and 2001. Therefore, some of the samples used predated the knowledge of the issue of acrylamide, the others were taken early in our understanding of acrylamide in food. Like the previous studies the aim of the 2014 TDS was to estimate the amount of acrylamide people are exposed to from food and identify those foods that contribute most to dietary exposure. Acrylamide levels were measured in food groups, representing the UK diet. Where appropriate these were prepared and cooked according to normal domestic practices or the on packet instructions.

Overall for the 2005 TDS acrylamide was quantified in seven of the twenty food groups analysed: bread, miscellaneous cereals, carcass meat, meat products, poultry, sugars and preserves and potatoes. It was not quantified in offal, fish, oil and fats, eggs, green vegetables, other vegetables, canned vegetables, fresh fruit, fruit products, beverages, milk, dairy products and nuts. Where appropriate, food in these groups had been prepared and cooked for consumption.

The 2005 TDS comprised one hundred and twenty food categories prepared for consumption and then pooled into twenty food groups. The 2014 TDS increased the number of categories to one hundred and thirty eight with a further eight Food groups surveyed for the first time. These new food groups were: Alcoholic drinks, Meat substitutes, Snacks and Desserts, Condiments, Tap water and Bottled waters. The Meat substitutes, Desserts, Sandwiches, Tap water and Bottled waters food groups each comprised a single food category. The Bottled waters group was classified as a category within the Beverage Group in earlier TDS surveys. The 2014 TDS acrylamide survey considered for the first time the potential release of acrylamide into public drinking water from the use of polyacrylamide based coagulants and flocculants for drinking

water purification, with the inclusion of the Tap water group. A strict limit is in place to restrict the residue of acrylamide from this use, as described in the results section.

Another benefit of the 2014 TDS is that the one hundred and thirty eight food categories were sampled individually as well as being pooled into food groups, so that if desired, now or in the future, a finer level of analysis can be undertaken to gain further insight on those foods contributing most to acrylamide exposure from the diet. A total of forty two of these food category samples were analysed for acrylamide in a study funded by the FSA[1]. These categories were selected for further analysis to better understand and permit quantification of their contribution to acrylamide dietary exposure.

A further food group 'Sandwiches' was also included as a popular, commonly consumed meal to provide a 'sense check' of the survey findings as a whole, based on a number of common sandwich fillings. Preliminary portion based exposure estimates for the sandwich group showed a good agreement with the corresponding food groups including bread.

Methodology

Sampling

The sampling method is documented in the contractor's report[2]

Samples were collected by the contractor HallMark Ltd. The 2014 TDS comprised one hundred and thirty eight food categories. Each category consisting of food items sampled from twenty four different UK towns, giving a total of three thousand three hundred and twelve samples. The one hundred and thirty eight food categories were pooled into twenty eight food groups. However, the Meat substitutes, Sandwiches, Tap water and Bottled waters food groups each contained a single food category.

[1] Total Diet Study – Acrylamide investigation: Phase 2 analysis of selected category samples, Food Standards Agency report, FS101169, April 2016.
[2] Final Report UK Total Diet Study FS102081, HallMark, Dec 2014.

The food items comprising the various food categories were prepared and cooked according to specified instructions agreed between the FSA and the analytical laboratory Fera (York).

Prepared sub-samples (100 g) for all 28 food groups were sent to Premier Analytical Services (PAS) for acrylamide analysis. Sub-samples from Groups 27 and 28 (Tap and Bottled waters respectively), together with laboratory control water samples, were transferred to 500 ml amber glass bottles and sent to a specialist laboratory (accredited UKAS/ISO17025) for the analysis of acrylamide in drinking water.

For completeness all food groups included in the TDS were tested for acrylamide although a number of these groups comprised food items not expected to be predisposed to acrylamide formation or were prepared raw without cooking or processing e.g. the Fresh fruit and Green vegetables food groups.

Analysis

Further details of the analytical method used in the study can be found in the contractor's laboratory report[3]

The analytical investigation used an accredited method for acrylamide. Defrosted samples were stirred thoroughly with a glass rod prior to analysis. Acrylamide was determined as the brominated derivative, 2-bromopropenamide using GC/MS/MS, according to the method of Hamlet, Sadd & Liang (2008)[4].

Drinking water samples were submitted to a specialist laboratory accredited (UKAS/ISO17025) for the analysis of acrylamide in drinking water. Acrylamide was measured by a direct aqueous injection procedure using LC/MS/MS. Samples of ultrapure laboratory water, both unspiked and spiked with acrylamide, were submitted as blind samples to the specialist laboratory to assess the validity of the method.

[3] Total Diet Study – Acrylamide Investigation: Phase 1 analysis of all group samples, Premier Analytical Services

[4] Hamlet, C G., Sadd, P.A & Liang, L (2008) Journal of Agricultural and Food Chemistry, 56, 6145 - 6153

The analysis of all food samples was performed by trained staff in a UKAS accredited laboratory operating an internal audit and review process. The test method for acrylamide was validated in-house and accredited by UKAS (ISO 17025).

Results

The levels of acrylamide for the food groups sampled in the 2014 TDS survey are presented in the analytical laboratory report[4].

The highest concentrations of acrylamide were measured in the Snacks (360 µg/kg), Potatoes (181 µg/kg) and Miscellaneous cereals (65 µg/kg) food groups. The lowest concentrations, at or below the limit of detection (LoD 0.008 µg/kg), were reported in the Tap water (0.008 µg/kg) and Bottle water (<0.008 µg/kg) Groups. The acrylamide levels for tap and bottle water were below EU[5]/ UK[6]/ limits of 0.1 µg/l for drinking water and the WHO 2011[7], guideline of 0.5 µg/l.

Discussion

For the 2005 acrylamide TDS, sample collection, composition of food groups, food preparation and cooking methods, differed in some cases from those used in the 2014 acrylamide TDS survey. Therefore, a simple comparison of acrylamide levels between survey years would not be realistic.

For example, the Potato group sample collected in 2003 underrepresented those foods consumed in the UK that are predisposed to acrylamide formation during cooking and/ or processing such as crisps and fried potato products. Furthermore, only a third of the potato and potato products included were baked or grilled; cooking practices implicated in acrylamide formation. The majority of products were boiled, steamed or prepared from instant mash potato. However, the 2001 acrylamide TDS Potato group did include crisps and baked potatoes. The measured acrylamide level for the 2001 collected sample

[5] EU Drinking water standard (Council Directive 98/83/EC)
[6] UK Statutory instrument SI 3184 as amended, SI2785
[7] WHO Water sanitation health - acrylamide in drinking water.

was used instead for the estimate of dietary exposure for the 2005 TDS[8]. For the 2014 TDS the sampling plan and food preparation instructions were specifically designed with acrylamide in mind, along with the other contaminants for which it was designed but which will be reported separately.

The acrylamide level for the 2001 potato group sample was 112 µg/kg compared with the 2003 sample result of 53 µg/kg. The corresponding level for the 2014 potato group sample was 181 µg/kg. This reflects the greater proportion of baked and fried potato based foods included in the 2014 TDS pooled composite sample, compared to the two previous TDS surveys.

Similarly the level of acrylamide recorded for the Bread food group in the 2005 TDS was (12 µg/kg). Toasted bread was not included in the pooled Bread group sample for the 2005 TDS study. The 2014 TDS reported 16 µg/kg for the Bread food group but again this is reflective of the inclusion of toasted bread in the composite sample. In some studies bread has been shown to contain an average level of 30 µg/kg, and toasted bread can contain acrylamide levels as high as 200 µg/kg[9].

Table 1 compares acrylamide levels by food group and the survey years 2005 and 2014 discussed in the text.

Table 1 Comparison of acrylamide levels used for exposure assessment by food group and survey year (µg/kg)

Food Group	2005 TDS[10]	2014 TDS
Snacks	Not sampled	360
Potatoes	53, 112 (2001)	181
Miscellaneous Cereals	57	65
Nuts	3	25
Sugars and Preserves	23	20
Meat Products	13	17
Bread	12	16
Offal	3	16

[8] FSIS No 71/05 Jan 2005 Analysis of Total Diet Study samples for acrylamide
[9] Acrylamide in the home, a report for the Food Standards Agency, Brooklyndhurst, Sect 5.5, https://www.food.gov.uk/science/research/chemical-safety-research/pc-research/fs102070
[10] For the 2005 TDS food groups where acrylamide was not quantified and the group does not have the potential for acrylamide formation, it has been assumed that acrylamide is present at 0 micrograms/kg

Fish	5	9
Milk	0	<0.5 (LoD)
Dairy	0	<0.5 (LoD)
Green Vegetables	0	<0.5 (LoD)
Poultry	6	7
Fruit Products	1	7
Fresh Fruit	0	<0.5 (LoD)
Beverages	1	6
Eggs	0	3
Carcass Meat	10	<3 (LoQ)
Oils and fats	0	<3 (LoQ)
Condiments	Not sampled	22
Other Vegetables	5	21
Desserts	Not sampled	20
Canned Vegetables	0	12
Sandwiches	Not sampled	12
Alcoholic Drinks	1	6
Non-Alcoholic Drinks	1	6
Tap Water	Not sampled	0.008 (LoD)
Bottle Waters	Not sampled	<0.008 (LoD)

Anomalous results for the 2014 Total Diet Study

The 2014 TDS milk group result of 6 µg/kg was unexpected and the first time milk had been identified as a potential dietary source of acrylamide. The 2005 TDS milk result was below the limit of detection.

Therefore a full investigation was undertaken with the analytical contractor. Fresh like for like milk samples were obtained and tested. Acrylamide was reported at 0.5 µg/kg the analytical method LoD.

Four other food groups were identified for retesting. These were Group 17 Non-alcoholic beverages, Group 21 Alcoholic beverages, Group 11 Green vegetables and Group 15 Fresh fruit.

The Green vegetables, Fresh fruit and Dairy products food groups were reviewed and assigned values of <LoD for calculating the exposure assessment.

Quality assurance procedures undertaken by the analytical contractor were scrutinised by the FSA and the analytical method and protocols for

detecting acrylamide were found to be robust. Investigations by the contractor into why these low levels of acrylamide were initially reported for these samples were not able to establish a cause. It is possible that there was an issue with the original analysis for these samples, a misreporting of the data or low level contamination during sample preparation or storage despite best efforts and protocols followed to ensure otherwise.

Exposure Assessment

The 2014 TDS concentration data (Table 1) were used for the estimation of dietary exposure to acrylamide. The consumption data used for estimating dietary exposure were from the National Diet and Nutrition Survey Rolling Programme (NDNS) (Bates et al., 2014). The Committee on Toxicity of chemicals in Food Consumer Products and Environment (COT) has considered the age range 0 to 5 years in its statement on potential risks from acrylamide in the diet of infants and young children[11].

Estimated exposures to acrylamide from each group of the TDS are shown in Annex 1, Table 1 and total dietary exposure is summarised for the different age classes in Table 2. Average total exposure to acrylamide in toddlers, young people and adults was in the region of 0.56 to 1.4 µg/kg bw/day. High-level total exposure in these age groups was between 1.1 and 2.9 µg/kg bw/day.

The dietary exposure estimates for each food group (Annex 1) show miscellaneous cereals and potato food groups as the main contributors to acrylamide exposure, as previously reported in the 2005 study. The exposure estimates are similar to those reported for the UK by EFSA and are within the range of other European countries.

[11] COT statement on potential risks from acrylamide in the diet of infants and young children https://cot.food.gov.uk/sites/default/files/finalacrylamidestatement.pdf

Table 2 Total estimated dietary exposure to acrylamide from food groups of the 2014 Total Diet Study across the age classes

Population group	Age Range (years)	Exposure estimate (µg/ kg bw/day)	
		Average[12]	High-level (97.5th percentile)
Toddlers	1.5 to 3	1.4	2.9
Young People	4 to 6	1.4	2.6
	7 to 10	1.1	2.2
	11 to 18	0.75	1.5
Adults	19+	0.56	1.1

Risk Assessment

The possible effects of acrylamide exposure include cancer, and effects on the nervous and reproductive systems. Most of the evidence is based on effects seen in experimental animals or animal and human cells studied in a laboratory. Whether or not acrylamide will cause these effects in humans will depend upon the level of exposure. It has long been known that acrylamide causes neurotoxicity in occupationally exposed people. However, the data for cancer and reproductive system effects in humans are not conclusive. (EFSA, 2015).

Statistical models are used to analyse dose response data from animal studies to generate a benchmark dose (BMD) and its lower confidence limit (BMDL), and to use the BMDL as a reference point for characterising the risks associated with human exposure. The BMDL is then divided by estimated human exposure to produce a "Margin of Exposure" (MOE). A large MOE indicates a low risk and a small MOE indicates a higher risk.

For the carcinogenicity of acrylamide, EFSA calculated a $BMDL_{10}$ (at which there is a 10% increase in incidence of tumours) of 0.17 mg/kg body weight (bw)/day, and considered that an MOE greater than 10,000 would indicate a low concern. For effects on the nervous system, EFSA

[12] The term average refers to average consumption at the population level as determined by the National Diet and Nutrition Survey Rolling Programme (NDNS). High level consumption includes increasing ranked levels of consumption up to and including the 97.5 percentile of the population. The very highest level of consumption at the population level would equate to the 100th percentile.

calculated a $BMDL_{10}$ of 0.43 mg/kg bw/day, and concluded that other effects, such as on the reproductive system would only occur at higher doses, and considered that an MOE greater than 100 would indicate low or no concern. Therefore the $BMDL_{10}$ of 0.43 mg/kg bw/day was used as a reference point for the non-cancer effects of acrylamide.

Table 5 shows the MOEs calculated for cancer and non-cancer effects of acrylamide. These indicate a possible concern about cancer risk, but not for the other effects of acrylamide.

Table 5 Margins of exposure for acrylamide[13]

Age range (years)	MOE for cancer		MOE for non-cancer effects	
	Average	High-level	Average	High-level
1.5 to 3	120	59	310	150
4 to 6	120	65	310	170
7 to 10	160	77	390	200
11 to 18	230	110	570	290
19+	300	160	770	390

Conclusion

Levels of acrylamide were found in most food groups in the 2014 TDS study and MOE were lower than would be considered of low concern. The Committee on Carcinogenicity (COC) advises that an MOE of less than 10,000, based on a $BMDL_{10}$ from an animal study may be a concern[14]

The major sources of dietary exposure were potatoes (particularly fried potatoes) and cereals (such as breakfast cereals and sweet biscuits).

While there have been significant efforts to reduce concentrations of acrylamide in key foods over recent years, the evidence so far is not

[13] A large MOE indicates a lower risk and a small MOE indicates a higher risk
[14] Cancer risk characterisation methods COC/G 06
https://www.gov.uk/government/publications/cancer-risk-characterisation-methods

sufficient to demonstrate whether there has been a decrease in dietary exposure. Due to the complexity of acrylamide formation and its presence in so many foods, ready to eat and home cooked, this is likely to be difficult to demonstrate. Nevertheless, some food sectors have been able to demonstrate progress in reducing acrylamide concentration levels[15]. However, this is not the same thing as saying that dietary exposure to acrylamide at the population level has been reduced.

The dietary acrylamide exposure levels for all age classes are of possible concern for an increased lifetime risk of cancer.

The results of the survey do not increase concern with respect to acrylamide in the UK diet but do reinforce FSA advice to consumers and our efforts to support the food industry in reducing acrylamide levels. The results of this TDS support the exposure assessments from EFSA for UK consumers but via a different approach. This increases overall confidence in both estimates.

[15] Acrylamide concentrations in potato crisps in Europe from 2002 to 2011, Food Additives & Contaminants: Part A, 30(9) pp1493=1500, ISSN 1944-0049, Mottram D.S. et al

Summary of Units

Microgram (µg): one thousandth of a milligram (mg)

Milligram (mg): one thousandth of a gram

Kilogram (kg): one thousand grams

Micrograms per kilogram (µg/kg)

Kilograms bodyweight (kg/bw)

Micrograms per kilogram body weight per day (µg/kg bw/day)

Glossary

Limit of Detection (LoD

The lowest concentration at which the analyte can be reliably detected by a particular measurement procedure.

Limit of Quantification (LoQ)

The lowest concentration of an analyte that can be determined with acceptable precision and accuracy under the stated conditions of the test.

Lower bound exposure (LB)

The measure of exposure based on a concentration where the analytical result is below the limit of detection and is assumed to have a value of zero.

Upper bound exposure (UB)

The measure of exposure based on a concentration where the analytical result is below the limit of detection and is assumed to have a value equal to the limit of detection or where the analytical result is above the limit of detection but below the limit of quantification is assumed to have a value equal to the limit of quantification

Average exposure at the population level

As determined by the National Diet and Nutrition Survey Rolling Programme (NDNS) the average amount of a given food consumed at

the population level. This level of consumption is used to calculate the average dietary exposure

High level 97.5th percentile exposure at the population level

As determined by the National Diet and Nutrition Survey Rolling Programme (NDNS) an above average consumption of a given food at the population level which includes increasing ranked levels of consumption up to and including the 97.5 percentile. The very highest level of consumption at the population level would equate to the 100th percentile.

Margin of exposure (MOE)

The MOE is a tool used by risk assessors to characterise the risk from exposure to genotoxic and carcinogenic substances, which may be found in food. As such, the MOE approach provides an indication of the level of safety concern about a substance's presence in food but it does not quantify the risk as such. The margin of exposure (MOE) is the numerical value obtained by dividing a point of departure on the dose response curve by estimated human exposure to the chemical.

References

1. Total Diet Study – Acrylamide investigation: Phase 2 analysis of selected category samples, Food Standards Agency report, FS101169, March 2016.
2. Final Report UK Total Diet Study FS102081, HallMark, Dec 2014
3. Total Diet Study – Acrylamide Investigation: Phase 1 analysis of all group samples, Premier Analytical Services
4. Hamlet, C.G, Sadd. P.A & Liang, L (2008), Journal of Agricultural and Food Chemistry, 56, 6145 – 6153.
5. EU Drinking water standard (Council Directive 98/83/EC)
6. UK Statutory instrument SI 3184 as amended, SI2785
7. WHO Water sanitation health - acrylamide in drinking water.
8. FSIS No 71/05 Jan 2005 Analysis of Total Diet Study samples for acrylamide

9. Acrylamide in the home, a report for the Food Standards Agency, Brooklyndhurst, Sect 5.5, https://www.food.gov.uk/science/research/chemical-safety-research/pc-research/fs102070

11 COT statement on potential risks from acrylamide in the diet of infants and young children https://cot.food.gov.uk/sites/default/files/finalacrylamidestatement.pdf

14 Cancer risk characterisation methods COC/G 06 https://www.gov.uk/government/publications/cancer-risk-characterisation-methods

15 Acrylamide concentrations in potato crisps in Europe from 2002 to 2011, Food Additives & Contaminants: Part A, 30(9) pp1493=1500, ISSN 1944-0049, Mottram D.S. et al

Annex 1

Table 1 provides lower-bound (LB) and upper-bound (UB) dietary exposures to acrylamide calculated using the TDS results. Values are presented as estimates based on lower-bound (LB) to upper-bound (UB) concentration data. The LB was calculated by treating concentration data below the limit of detection (LOD) as 0, while the UB was determined by treating values <LOD as equal to the LOD. If there is only one measured value shown in Table 1, then all concentration data were above the LOD. The consumption data used for estimating dietary exposure were from the National Diet and Nutrition Survey Rolling Programme (NDNS) (Bates et al., 2014). Exposure data for each food group is reported separately so that the contribution to exposure from each food group could be assessed more transparently for the most relevant age group. In addition, the total exposure from the diet is also provided.

Table 1. Estimated dietary exposures in UK children (age 1.5 to 18 years) and adults to acrylamide analysed in different food groups from the Total Diet Study.

Dietary exposure (µg/kg bw/day)										
Food Groups	**1½ to 3 years**		**4 to 6 years**		**7 to 10 years**		**11 to 18 years**		**Adults 19+ years**	
	Mean	**High level**	**Mean**	**High level**	**Mean**	**High level**	**Mean**	**High level**	**Mean**	**High level**
Bread	0.051	0.132	0.051	0.106	0.039	0.087	0.023	0.056	0.018	0.043
Miscellaneous cereals	0.405	0.996	0.362	0.896	0.309	0.714	0.176	0.470	0.108	0.292
Carcase meat	0-0.003	0-0.016	0-0.002	0.000-0.011	0-0.002	0-0.011	0-0.002	0-0.008	0-0.002	0-0.006
Offal	0	0	0	0	0	0	0	0	0	0.005
Meat products	0.028	0.096	0.028	0.095	0.022	0.077	0.015	0.054	0.010	0.037
Poultry	0.008	0.032	0.008	0.026	0.008	0.028	0.006	0.022	0.004	0.016
Fish	0.008	0.031	0.007	0.030	0.005	0.020	0.002	0.013	0.004	0.016
Fats and oils	0-0.001	0-0.004	0-0.001	0-0.004	0-0.001	0-0.003	0	0-0.002	0	0-0.001
Eggs	0.002	0.009	0.001	0.009	0.001	0.005	0.001	0.004	0.001	0.003
Sugars	0.018	0.078	0.020	0.069	0.019	0.078	0.010	0.040	0.006	0.025
Green veg	0-0.001	0-0.002	0-0.001	0-0.002	0	0-0.002	0	0-0.001	0	0-0.001
Potatoes	0.559	1.570	0.549	1.661	0.451	1.092	0.301	0.774	0.222	0.572
Other veg	0.045	0.161	0.047	0.137	0.035	0.138	0.021	0.081	0.031	0.096
Canned veg	0.025	0.103	0.017	0.066	0.012	0.059	0.007	0.035	0.006	0.030
Fresh fruit	0-0.004	0-0.009	0-0.003	0-0.008	0-0.002	0-0.004	0-0.001	0-0.003	0-0.001	0-0.002
Fruit products	0.027	0.133	0.028	0.131	0.022	0.096	0.010	0.051	0.005	0.031
Non-alcoholic beverages	0.127	0.394	0.096	0.298	0.077	0.216	0.062	0.164	0.076	0.173
Milk	0-0.011	0-0.029	0-0.006	0-0.016	0-0.003	0-0.010	0-0.002	0-0.006	0-0.001	0-0.003
Dairy products	0-0.003	0-0.012	0-0.002	0-0.007	0-0.001	0-0.004	0-0.001	0-0.002	0-0.001	0-0.002
Nuts	0.001	0.013	0.001	0.017	0.001	0.010	0.001	0.008	0.001	0.010
Alcoholic drinks	0	0	0	0	0	0.001	0.004	0.068	0.020	0.114
Meat substitutes	0	0.004	0.001	0.015	0	0.005	0	0.003	0	0.006
Snacks	0.102	0.593	0.139	0.587	0.124	0.494	0.093	0.457	0.033	0.190
Desserts	0.005	0.044	0.006	0.050	0.005	0.039	0.002	0.025	0.002	0.018
Condiments	0.012	0.064	0.012	0.049	0.011	0.044	0.008	0.030	0.007	0.030
Tap water	0	0	0	0	0	0	0	0	0	0
Bottled water	0	0	0	0	0	0	0	0	0	0
Total	**1.423-1.444**	**2.863-2.896**	**1.374-1.388**	**2.594-2.622**	**1.140-1.149**	**2.158-2.166**	**0.743-0.747**	**1.476-1.480**	**0.557-0.561**	**1.091-1.086**

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