



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Institute for Health and Consumer Protection
Unit for Molecular Biology and Genomics

EURL
European Union Reference Laboratory
for GM Food & Feed

Event-specific Method for the Quantification of Soybean Line MON 89788 Using Real-time PCR

Validated Method

18 February 2008

Corrected version 1 - 28/08/2013 (see page 2)

**Joint Research Centre
Institute for Health and Consumer Protection
Unit for Molecular Biology and Genomics**

Method development:

Monsanto Company

Collaborative trial:

European Union Reference Laboratory for GM Food and Feed (EURL-GMFF)
Unit for Molecular Biology and Genomics

Quality assurance

The EURL GMFF is ISO 17025:2005 accredited [certificate number: ACCREDIA 1172, (Flexible Scope for DNA extraction and qualitative/quantitative PCR) - Accredited tests are available at http://www.accredia.it/accredia_labsearch.jsp?ID_LINK=293&area=7].

The original version of the document containing evidence of internal checks and authorisation for publication is archived within the EURL GMFF quality system.

The EURL GMFF is also ISO 17043:2010 accredited (Proficiency test provider) and apply the corresponding procedures and processes for the management of ring trials during the method validation.

The EURL GMFF conducts its activities under the certification ISO 9001:2008 of the IHCP Institute provided by CERMET

Correction from the previous version:

Corrected version 1 - 28/08/2013

Page 1 and 2: new layout

Page 4, 6, 7, 8, 9, 10 :
lec changed by Le1

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1. General information and summary of the methodology

This protocol describes an event-specific real-time quantitative TaqMan[®] PCR procedure for the determination of the relative content of soybean event MON 89788 DNA to total soybean DNA in a sample.

The PCR assay was optimised for use in real-time PCR instruments for plastic reaction vessels. Glass capillaries are not recommended for the buffer composition described in this method.

Template DNA extracted by means of suitable methods should be tested for quality and quantity prior to use in PCR assay. Tests for the presence of PCR inhibitors (e.g. monitor run of diluted series, use of DNA spikes) are recommended.

For the specific detection of soybean event MON 89788 DNA, a 139-bp fragment of the integration region of the construct inserted into the plant genome (5' insert-to-plant junction) is amplified using two specific primers. PCR products are measured at each cycle (real-time) by means of a target-specific oligonucleotide probe labelled with FAM dye and TAMRA as quencher dye.

For the relative quantification of soybean event MON 89788 DNA, a soybean-specific reference system amplifies a 74-bp fragment of the soybean endogenous *lectin* gene (*Le1*), using a pair of specific primers and a *Le1* gene-specific probe labelled with FAM and TAMRA as described above.

The measured fluorescence signal passes a threshold value after a certain number of cycles. This threshold cycle is called the "Ct" value. For quantification of the amount of event MON 89788 DNA in a test sample, MON89788 and *Le1* Ct values are determined for the sample. Standard curves are then used to estimate the relative amount of soybean event MON89788 DNA to total soybean DNA.

2. Validation status and performance characteristics

2.1 General

The method was optimised for suitable DNA extracted from soybean seeds and grains containing mixtures of genetically modified and conventional soybean.

The reproducibility and trueness of the method were tested through an international collaborative ring trial using DNA samples at different GMO contents.

2.2 Collaborative trial

The method was validated in a collaborative study by the Joint Research Centre (JRC) of the European Commission. The study was undertaken with twelve participating laboratories in August 2007.

Each participant received twenty blind samples containing MON 89788 genomic DNA at five GM contents, ranging from 0.10 % to 8.0 %.

Each test sample was analysed by PCR in three repetitions. The study was designed as a blind quadruplicate collaborative trial; each laboratory received each level of GM MON 89788 in four unknown samples. Four replicates of each GM level were analysed on the same PCR plate.

A detailed validation report can be found at <http://gmo-crl.jrc.it/statusofdoss.htm>

2.3 Limit of detection (LOD)

According to the applicant, the relative LOD of the method is at least 0.045% in 200 ng of total soybean DNA. The relative LOD was not assessed in a collaborative study.

2.4 Limit of quantification (LOQ)

According to the applicant, the relative LOQ of the method is at least 0.09% in 200 ng of total soybean DNA. The lowest relative GM content of the target sequence included in collaborative trial was 0.10 %.

2.5 Molecular specificity

According to the applicant, the method exploits a unique DNA sequence in the region of recombination between the insert and the plant genome; the sequence is specific to soybean event MON 89788 and thus imparts event-specificity to the method.

The specificity of event-specific assay was experimentally tested by the applicant in real-time PCR against DNA extracted from plant materials containing the specific targets of soybean MON 89788, Roundup Ready[®] Canola (RT200), Roundup Ready[®] Canola (RT73), Conventional Canola, Roundup Ready[®] Corn (GA21), Roundup Ready[®] Corn (NK603), YieldGard[®] Corn Borer Corn (MON810), YieldGard[®] Rootworm/Roundup Ready[®] Corn (MON88017) , YieldGard[®] Rootworm corn (MON863), Lysine Maize (LY038), Conventional Corn, Roundup Ready[®] Cotton (MON1445), Bollgard[®] Cotton(MON531), Bollgard[®] Cotton (MON757), BollgardII[®] Cotton (MON15985), Cotton MON88913, Conventional Cotton, Roundup Ready[®] soybean 40-3-2, Conventional Soybean, Roundup Ready[®] Wheat (MON71800), Conventional Wheat, Lentil, Sunflower nuts, Rye berries, Peanuts (shelled), Pinenuts, Quinoa, Millet.

None of the GM-lines tested, except the positive control soybean line MON 89788, yielded detectable amplicons.

The specificity of the soybean reference assay *Le1* was experimentally tested by the applicant against DNA extracted from plant materials containing soybean MON 89788, Roundup Ready® Canola (RT200), Roundup Ready® Canola (RT73), Conventional Canola, Roundup Ready® Corn (GA21), Roundup Ready® Corn (NK603), YieldGard® Corn Borer Corn (MON810), YieldGard® Rootworm/Roundup Ready® Corn (MON88017), YieldGard® Rootworm corn (MON863), Lysine Maize (LY038), Conventional Corn, Roundup Ready® Cotton (MON1445), Bollgard® Cotton(MON531), Bollgard® Cotton (MON757), BollgardII® Cotton (MON15985), Cotton MON88913, Conventional Cotton, Roundup Ready® soybean 40-3-2, Conventional Soybean, Roundup Ready® Wheat (MON71800), Conventional Wheat, Lentil, Sunflower nuts, Rye berries, Peanuts (shelled), Pinenuts, Quinoa, Millet. None of the samples tested, except the positive control soybean line MON 89788, the Roundup Ready® soybean 40-3-2 and conventional soybean, yielded detectable amplicons.

3. Procedure

3.1 General instructions and precautions

- The procedures require experience of working under sterile conditions.
- Laboratory organisation, e.g. "forward flow direction" during PCR-setup, should follow the guidelines given by relevant authorities, e.g. ISO 24276
- PCR-reagents should be stored and handled in a separate room where no nucleic acids (with exception of PCR primers or probes) or DNA degrading or modifying enzymes have been handled previously. All handling of PCR reagents and controls requires dedicated equipment, especially pipettes.
- All the equipment used should be sterilised prior to use and any residue of DNA has to be removed. All material used (e.g. vials, containers, pipette tips, etc.) must be suitable for PCR and molecular biology applications. They must be DNase-free, DNA-free, sterile and unable to adsorb protein or DNA.
- Filter pipette tips protected against aerosol should be used.
- Powder-free gloves should be used and changed frequently.
- Laboratory benches and equipment should be cleaned periodically with 10% sodium hypochloride solution (bleach).
- Pipettes should be checked regularly for precision and calibrated, if necessary.
- All handling steps - unless specified otherwise - should be carried out at 0 - 4°C.
- In order to avoid repeated freeze/thaw cycles aliquots should be prepared.

3.2 Real-time PCR for quantitative analysis of soybean event MON 89788

3.2.1 General

The PCR set-up for the taxon specific target sequence (*Le1*) and for the GMO (event MON 89788) target sequence should be carried out in separate vials. Multiplex PCR (using differential fluorescent labels for the probes) has not been tested or validated.

The use of maximum 200 ng of template DNA per reaction well is recommended. The method is developed for a total volume of 50 µl per reaction mixture with the reagents as listed in Table 1 and Table 2.

3.2.2 Calibration

The calibration curves consist of five samples. The first point of the calibration curves is a 10% MON 89788 in non-GM soybean DNA for a total of 200 ng of DNA (corresponding to 176,991 soybean genome copies with one genome assumed to correspond to 1.13 pg of haploid soybean genomic DNA) ⁽¹⁾.

A calibration curve is produced by plotting the Ct-values against the logarithm of the target copy number for the calibration points. This can be done e.g. by means of spreadsheet software, e.g. Microsoft Excel, or directly by options available with the sequence detection system software.

The copy number measured for the unknown sample DNA is obtained by interpolation from the standard curves.

The ratio of transgene copy number and reference gene copy number multiplied by 100 gives the % GM contents of the samples.

3.2.3 Real-time PCR set-up

1. Thaw, mix gently and centrifuge the required amount of components needed for the run. **Keep thawed reagents at 1-4°C on ice.**
2. In two reaction tubes (one for the MON 89788 system and one for the *Le1* system) on ice, add the following components (Tables 1 and 2) in the order mentioned below (except DNA) to prepare the master mixes.

Table 1. Amplification reaction mixture in the final volume/concentration per reaction well for the MON89788 specific system.

| Component | Final concentration | µl/reaction |
|---------------------------------------|---------------------|-------------|
| TaqMan® Universal PCR Master Mix (2x) | 1x | 25 |
| MON 89788-F (10 µM) | 150 nM | 0.75 |
| MON 89788-R (10 µM) | 150 nM | 0.75 |
| MON 89788-P (5 µM) | 50 nM | 0.50 |
| Nuclease free water | # | 19 |
| Template DNA (max 200 ng) | # | 4.0 |
| Total reaction volume: | | 50 |

Table 2. Amplification reaction mixture in the final volume/concentration per reaction well for the soybean *Le1* reference system.

| Component | Final concentration | µl/reaction |
|---------------------------------------|---------------------|-------------|
| TaqMan® Universal PCR Master Mix (2x) | 1x | 25 |
| <i>Le1</i> F (10 µM) | 150 nM | 0.75 |
| <i>Le1</i> R (10 µM) | 150 nM | 0.75 |
| <i>Le1</i> P (5 µM) | 50 nM | 0.50 |
| Nuclease free water | # | 19 |
| Template DNA (max 200 ng) | # | 4.0 |
| Total reaction volume: | | 50 |

3. Mix gently and centrifuge briefly.
4. Prepare two reaction tubes (one for the MON 89788 and one for the *Le1* master mixes) for each DNA sample to be tested (standard curve samples, unknown samples and control samples).
5. Add to each reaction tube the correct amount of master mix (e.g. $46 \times 3 = 138$ µl master mix for three PCR repetitions). Add to each tube the correct amount of DNA (e.g. $4 \times 3 = 12$ µl DNA for three PCR repetitions). Vortex each tubes for approx. 10 sec. This step is mandatory to reduce to a minimum the variability among the repetitions of each sample to a minimum.
6. Spin down the tubes in a microcentrifuge. Aliquot 50 µl in each well. Seal the reaction plate with optical cover or optical caps. Centrifuge the plate at low speed (e.g. approximately 250 x *g* for 1 minute at 4 °C to room temperature) to spin down the reaction mixture.
7. Place the plate into the instrument.
8. Run the PCR with cycling conditions described in Table 3:

Table 3. Cycling program for MON89788/*Le1* systems

| Step | Stage | T°C | Time (sec) | Acquisition | Cycles | |
|------|----------------------|-----------------------|------------|-------------|--------|----|
| 1 | UNG | 50 °C | 120 | No | 1 | |
| 2 | Initial denaturation | 95 °C | 600 | No | 1 | |
| 3 | Amplification | Denaturation | 95 °C | 15 | No | 45 |
| | | Annealing & Extension | 60 °C | 60 | Yes | |

3.3 Data analysis

Subsequent to the real-time PCR, analyse the run following the procedure below:

- Set the threshold: display the amplification curves of one system (e.g. MON 89788) in logarithmic mode. Locate the threshold line in the area where the amplification profiles are parallel (exponential phase of PCR) and where there is no "fork effect" between repetitions of the same sample. Press the "update" button to ensure changes affect Ct values. Switch to the linear view mode by clicking on the Y axis of the amplification plot, and check that the threshold previously set falls within the geometric phase of the curves.
- Set the baseline: determine the cycle number at which the threshold line crosses the first amplification curve and set the baseline three cycles before that value (e.g. earliest Ct = 25, set the baseline crossing at $Ct = 25 - 3 = 22$).
- Save the settings.
- Repeat the procedure described in a) and b) on the amplification plots of the other system (e.g. *Le1* system).
- Save the settings and export all the data to a text file for further calculations.

3.4 Calculation of results

After having defined a threshold value within the logarithmic phase of amplification as described above, the instrument's software calculates the Ct-values for each reaction.

The standard curves are generated both for the *Le1* and the MON 89788 specific systems by plotting the Ct values measured for the calibration points against the logarithm of the DNA copy numbers and by fitting a linear regression line into these data.

Thereafter, the standard curves are used to estimate the copy numbers in the unknown sample DNA.

For the determination of the amount of event MON89788 DNA in the unknown sample, the MON89788 copy number is divided by the copy number of the soybean reference gene (*Le1*) and multiplied by 100 to obtain the percentage value ($GM\% = \text{MON 89788}/Le1 * 100$).

4. Materials

4.1 Equipment

- Real-time PCR instrument for plastic reaction vessels (glass capillaries are not recommended for the described buffer composition)
- Plastic reaction vessels suitable for real-time PCR instrument (enabling undisturbed fluorescence detection)
- Software for run analysis (mostly integrated in the software of the real-time PCR instrument)
- Microcentrifuge
- Micropipettes
- Vortex
- Rack for reaction tubes
- 1.5/2.0 ml reaction tubes

4.2 Reagents

- TaqMan® Universal PCR Master Mix (2X). Applied Biosystems Part No 4304437

4.3 Primers and Probes

| Name | Oligonucleotide DNA Sequence (5' to 3') |
|---|---|
| MON 89788 target sequence | |
| MON 89788-F | 5' – TCC CGC TCT AGC GCT TCA AT – 3' |
| MON 89788-R | 5' – TCG AGC AGG ACC TGC AGA A – 3' |
| MON 89788-P (Probe) | 6-FAM 5' – CTG AAG GCG GGA AAC GAC AAT CTG – 3' TAMRA |
| Reference gene <i>Le1</i> target sequence | |
| <i>Le1</i> F | 5' – CCA GCT TCG CCG CTT CCT TC – 3' |
| <i>Le1</i> R | 5' – GAA GGC AAG CCC ATC TGC AAG CC – 3' |
| <i>Le1</i> P (Probe) | 6-FAM 5' – CTT CAC CTT CTA TGC CCC TGA CAC – 3' TAMRA |

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European Commission
EUR 26153 EN – Joint Research Centre – Institute for Health and Consumer Protection

Title: Event-specific Method for the Quantification of Soybean Line MON 89788 Using Real-time PCR - Validation Report corr. version 1 and Validated Method corr. version 1

Author(s): Chrystelee Delobel, Alessia Bogni, Gregor Pinski, Marco Mazzara, Guy Van den Eede

Luxembourg: Publications Office of the European Union

2013 – 32 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424

ISBN 978-92-79-33078-0

doi: 10.2788/20464

Abstract

The JRC as European Union Reference Laboratory for GM Food and Feed (EURL-GMFF), established by Regulation (EC) No 1829/2003, in collaboration with the European Network of GMO Laboratories (ENGL), has carried out a collaborative study to assess the performance of a quantitative event-specific method to detect and quantify the MON89788 transformation event in soybean DNA (unique identifier MON-89788-1). The collaborative trial was conducted according to internationally accepted guidelines (1, 2).

In accordance with Regulation (EC) No 1829/2003 of 22 September 2003 on genetically modified food and feed and with Regulation (EC) No 641/2004 of 6 April 2004 on detailed rules for the implementation of Regulation (EC) No 1829/2003, Monsanto provided the detection method and the samples (soybean seeds containing the transformation event and conventional soybean seeds). The JRC prepared the validation samples (calibration samples and blind samples at unknown GM percentage [DNA/DNA]). The collaborative trial involved twelve laboratories from eight European countries.

The results of the international collaborative trial met the ENGL performance requirements. The method is therefore considered applicable to the control samples provided, in accordance with the requirements of Annex I-2.C.2 to Commission Regulation (EC) No 641/2004.

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security, including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

doi: 10.2788/20464

ISBN 978-92-79-33078-0

