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Quantification of 16S rRNA Gene Copies Using ddPCR (EvaGreen-based assay: 338F-805R) V.3

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Protocol status: Working
We use this protocol and it's working

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Abstract

This protocol describes how to quantify 16S rRNA bacterial gene or transcript copy numbers using **Droplet Digital PCR technology (ddPCR)** from Bio-Rad. This is an up-to-date modification of a classical bacterial enumeration qPCR-assay. This assay uses the EvaGreen™ chemistry. The primers are taken from **Yu et al. (2005)**.

Note

Advantages of ddPCR over qPCR
Among the biggest advantages of the ddPCR technique are its high sensitivity (down to one molecule of target gene presented in input DNA) and low sensitivity to enzymatic inhibitors. Moreover, because it is an absolute and direct quantification technique, no external standard is needed for evaluation.

Citation

Yu Y, Lee C, Kim J, Hwang S (2005)
. Group-specific primer and probe sets to detect methanogenic communities using quantitative real-time polymerase chain reaction..
Biotechnology and bioengineering.

Attachments

MSDS-EvaGreen.pdf

32KB

Guidelines

1. Just like for qPCR, careful and precise pipetting, and adequate mixing and dilutions are crucial to the success of the assay.
2. Keep in mind that ddPCR works with a lower dynamic concentration range compared to qPCR does.
3. One can easily overload the reaction with too much template DNA because ddPCR requires that a certain proportion of the droplets remain empty. Ideally, a ddPCR reaction should contain between 10^1 - 10^4 copies of the target gene. If the expected copy-number range cannot be assumed in advance it is advisable to prepare several dilutions of the sample in parallel and analyse them together.
4. The ddPCR Droplet Reader processes the samples in batches of 8. Therefore, even if the total number of samples is not a multiplication of 8 all the columns in the plate must be filled with reagents.

Materials

STEP MATERIALS

- ddPCR 96-well plates **Bio-Rad Laboratories Catalog #**12001925
- QX200™ ddPCR™ EvaGreen Supermix **Bio-Rad Laboratories Catalog #**1864033
- PCR Plate Heat Seal foil piercable **Bio-Rad Laboratories Catalog #**1814040
- Automated Droplet Generation Oil for EvaGreen **Bio-Rad Laboratories Catalog #**1864112
- PCR Plate Heat Seal foil piercable **Bio-Rad Laboratories Catalog #**1814040

Protocol materials

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Troubleshooting

Safety warnings

See the regulations of your institute for proper handling and disposal of DNA-intercalating dyes. The MSDS of the EvaGreen dye is enclosed in this protocol.

Before start

Take all the reagents out of the freezer and allow them to reach room temperature.

Primers

1 The assay uses the following universal 16S bacteria primers:

	Name	Direction	Sequence	Target region[1]
	BAC338F	F	ACT CCT ACG GGA GGC AG	338-354
	BAC805R	R	GAC TAC CAG GGT ATC TAA TC	785-805

1. Relative to *E. coli* SSU rRNA gene

PCR mixture

40m

2 All reagents must be equilibrated to Room temperature (do not keep them on ice). Mix each of them properly before use.

20m

3

	Reagent	Final conc.	1 tube (22 µl)	plate (22 µl x 100)
	PCR H_2O		8.6	860
	QX200 ddPCR EvaGreen Supermix	1x	11	1100
	BAC 338F (10 µM)	0.1 µM	0.2	20
	BAC 805R (10 µM)	0.1 µM	0.2	20
	Template		2	2 × 100

10m

Prepare the master mix according to the number of samples (incl. at least one NTC sample) and mix for several seconds by vortexing or pipetting. Transfer mix into 96-well plate à 20 µL .

ddPCR 96-well plates **Bio-Rad Laboratories Catalog #**12001925

QX200™ ddPCR™ EvaGreen Supermix **Bio-Rad Laboratories Catalog #**1864033

Note

Tip: use a mechanical or electronic dispenser (e.g. Multipette, Pipettman, or a multichannel pipette) during this step to speed up the work.

4 Add 2 µL DNA template into each well. 5m

5 Seal the plate (00:00:05 180 °C) with a pierceable aluminium foil. 5s

PCR Plate Heat Seal foil piercable **Bio-Rad Laboratories Catalog #**1814040

Equipment

PX1 PCR Plate Sealer	NAME
Plate Sealer	TYPE
Bio-Rad	BRAND
1814000	SKU
https://www.bio-rad.com/en-at/sku/1814000-px1-pcr-plate-sealer?ID=1814000	LINK

PX1 Plate Sealer set-up

6 Let the foil cool down and mix the plate vigorously by vortexing for 00:00:30 - 00:01:00

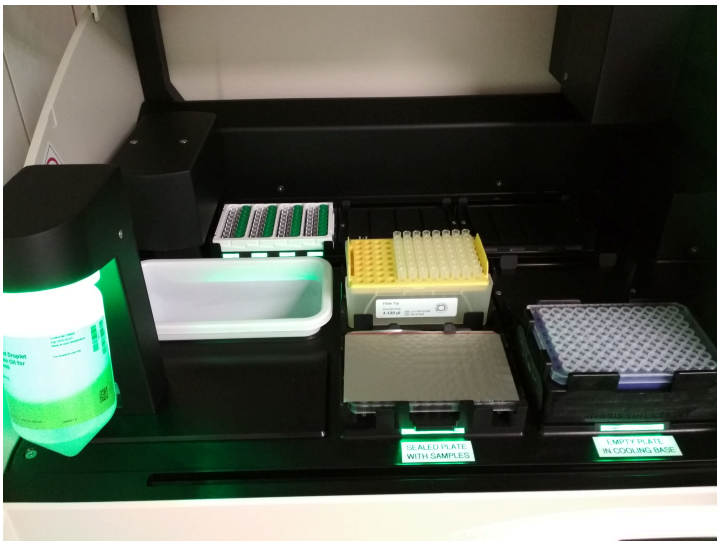
Droplet generation using AutoDG

1h

7 Place the cartridges, tips, sealed plate with samples and an empty 96-well plate into their appropriate positions in the **QX200 AutoDG Droplet Digital PCR System** (Bio-Rad). 40m

Note

Note: Two pipette tips are needed for each sample!



This is how it should look like inside the AutoDG before starting droplets generation

Equipment

Automated Droplet Generator	NAME
Droplet Digital PCR System	TYPE
Bio-Rad	BRAND
1864101	SKU
https://www.bio-rad.com/en-at/sku/1864101-automated-droplet-generator?ID=1864101	LINK

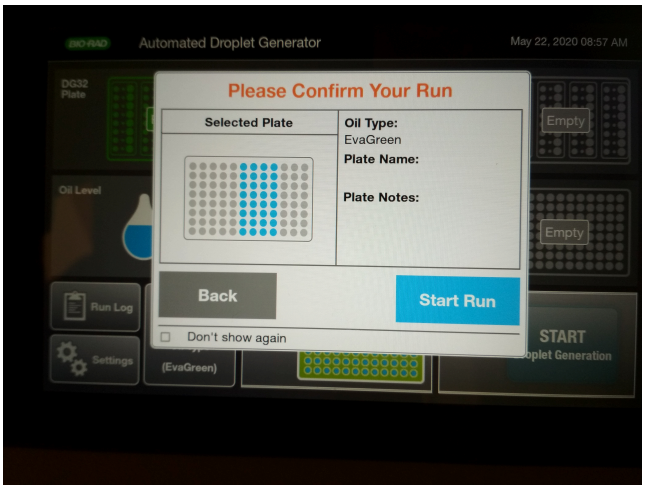
8 Make sure that the correct oil bottle—**Automated Droplet Generation oil for EvaGreen**—is connected to the system.

Automated Droplet Generation Oil for EvaGreen **Bio-Rad Laboratories Catalog #**1864112

Note

The droplet generation oil is prone to expire about one year after opening. Replace the oil if it has turned milky.

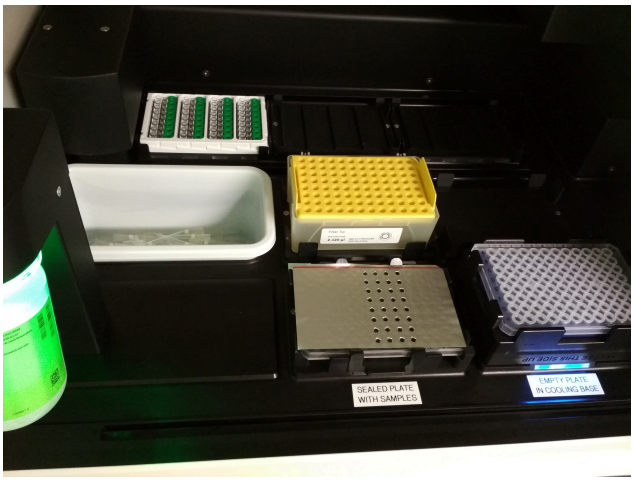
9 Mark the position of the samples in the plate on the touch screen and press "START" initiate the droplet generation.



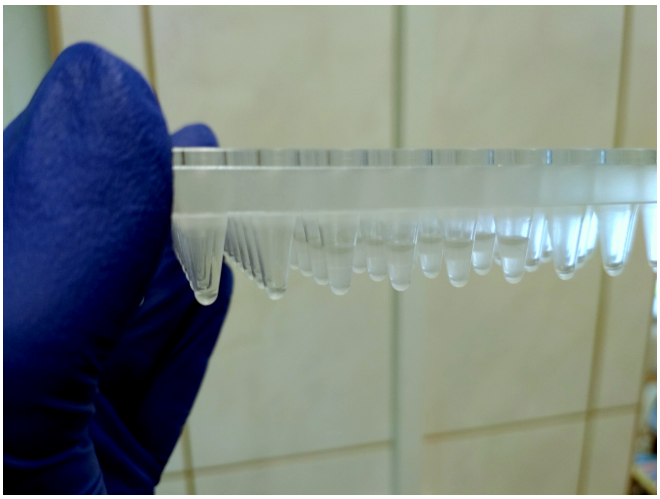
A confirmation window will appear on the screen before the procedure starts. Make sure you have chosen the right positions of the samples.

Note

After the droplet generation is finished, the system will you automatically display a message about the success or failure of the procedure. Nevertheless, even after a successful run, it is advisable to inspect the wells and ensure that two separated phases are clearly visible. Upper part with droplets and lower clear oil phase.



This is how it should look like inside the AutoDG after droplets generation



The 96-well plate after droplet generation: two phases are visible in each well containing a sample

10 Take the plate with droplets out of the AutoDG and seal it with pierceable aluminium foil (170 °C , 00:00:03).

PCR Plate Heat Seal foil piercable **Bio-Rad Laboratories Catalog #**1814040

11 Immediately place the sealed plate into PCR cycler (see below) and initiate the reaction.

Note

The droplets are unstable at this stage. Proceed to the next step as soon as possible. Following PCR, the droplets become stable and can be kept at 4 °C for some time (up to 24 hours) before measurement.

12 Clean the AutoDG and discard used consumables.

PCR program

13 3h

1. 95 °C 00:05:00
2. x 5 {
   a. 95 °C 00:00:30
   b. 60 °C 00:02:30 ' (-1 °C each step)
   }
3. x 35 {
   a. 95 °C 00:00:30
   b. 55 °C 00:02:30
   }
4. 4 °C 00:05:00
5. 90 °C 00:05:00
6. 10 °C hold

Settings:

1. Set the ramp rate for each step to 2°C/sec.
2. Set the reaction volume to 40 µL .

Note

- After the run is finished check if there are still two phases present.
- Let the plate cool down before downstream measurement
- To maximise the droplet count, leave the plate overnight in a fridge before processing the samples in the QX200 Droplet Reader. This is because the droplets tend to stick together after the PCR step, but loose this tendency after prolonged co

Equipment

T100™ Thermal Cycler	NAME
Thermal Cycler	TYPE
Bio-Rad	BRAND
1861096	SKU
https://www.bio-rad.com/en-at/product/t100-thermal-cycler?ID=LZJU45E8Z	LINK

Droplet reading

30m

14 Put the plate into a metal holder, place them together into **QX200 Droplet Reader**.

1h

Note

Switch on the reader 30 min before measurement.

Droplet reader with a plate after PCR already placed inside the metal holder

Equipment

X200™ Droplet Reader	NAME
Droplet Reader	TYPE
Bio-Rad	BRAND
1864003	SKU
https://www.bio-rad.com/en-at/sku/1864003-qx200-droplet-reader?ID=1864003	LINK

15 **Set up the QuntaSoft experiment as follows:**

	Exp. type	Absolute quantification (ABS)
	Supermix	EvaGreen ddPCR Supermix
	Target1	Ch1

Define the position of each sample.

16 Check the levels of reader Oil and waste - green control (bottles are physically accessible from the left side of the device).

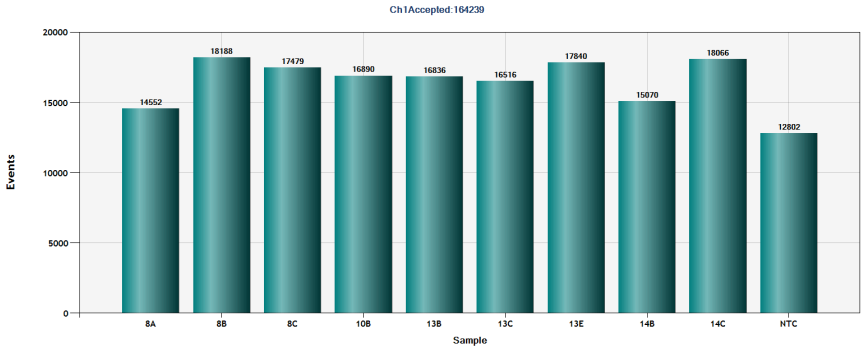
Note

If the instrument was not in use for longer than one week, it has to be primed first (oil flushed).

17 Start the measurement.

Note

After the count is finished go over the results and check how many droplets were counted for each sample. To get a reliable count the number of droplet should be above 12.000. On average, droplet counts range from 16.000 to 18.000.



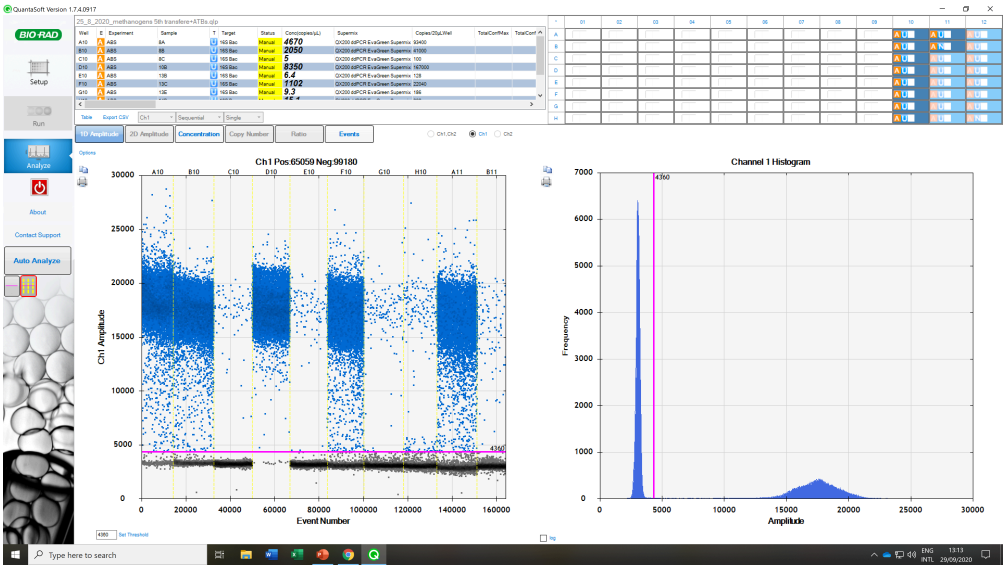
An example of total events = droplet counts (positives and negatives together) for ten samples.

Analysis

18 Set the threshold just above the negative control sample in order to distinguish positive (droplets containing PCR products) from negative (empty) droplets.

Note

QuantaSoft will automatically calculate a copy number of the target gene for each sample using its Poisson distribution algorithm. For these calculations, a certain portion for the droplets must be negative. If the sample contains only positive droplets it cannot be evaluated properly (see an example below).



An example of 16S Bac copy numbers data analysis. The right-most sample is a negative-control sample (NTC), according to which a threshold was set up. Sample 4 (well D10) shows an overloaded sample with an insufficient number of negative (empty) droplets. The quantification for this sample is inaccurate and the sample should be repeated with a higher dilution.

Software

QuantaSoft Analysis Pro	NAME
Windows 7 or Windows 10, 64 bit 1.7.4	OS
Bio-Rad Laboratories	DEVELOPER
http://www.bio-rad.com/webroot/web/pdf/lsr/literature/10047467.pdf	SOURCE LINK

19 Export a CSV file with concentrations (copies μl^{-1}). To obtain the number of copies in 1 µl of template DNA use the following formula:
no. of copies in 1 µl of template DNA = ddPCR conc. x 22 / volume of template DNA

Citations

Yu Y, Lee C, Kim J, Hwang S. Group-specific primer and probe sets to detect methanogenic communities using quantitative real-time polymerase chain reaction.