PROPIDIUM MONOAZIDE (PMA)-qPCR FOR QUANTITATIVE DIFFERENTIATION OF LIVE HUMAN-ASSOCIATED *Bacteroides*

1. SCOPE AND APPLICATION

1.1. This method describes a quantitative polymerase chain reaction (qPCR) procedure targeting the 16S rRNA gene of human associated *Bacteroides* with a propidium monoazide (PMA) modification. This method is used for quantitative differentiation of live cells in water with the LIMS Test ID PMA-HF183.

1.2. PMA is a photoreactive DNA binding dye. The dye intercalates into double stranded DNA (dsDNA) upon exposure to intense visible light, resulting in chemically modified DNA that cannot be amplified with PCR. The dye cannot penetrate the cell membrane and will modify only exposed DNA from dead cells while leaving DNA from viable cells unmodified.

2. SUMMARY OF METHOD

2.1. Bacteria present in a water sample are collected by filtration. PMA is added to the filter and incubated in the dark. The sample is then exposed to high intensity light for photolysis to occur, resulting in the dye covalently reacting with exposed dsDNA from dead cells. DNA is extracted from the filter using a bead beating method with a DNA purification kit. The extract is analyzed with qPCR.

2.2. Interferences: Particulate matter present in the environmental matrix can potentially limit the dye from accessing the DNA molecules. Concentrating solids or other inhibitors during filtration might interfere with the covalent bonding of PMA to DNA. Some substances, including humic and tannic acids, can act as inhibitors and reduce efficiency by either binding to the DNA polymerase or interfering with the annealing and extension cycles. Sample purification or dilution can help alleviate the effects of inhibitors.

3. EQUIPMENT AND SUPPLIES

3.1. Equipment –

Equipment Name	Notes
Tube Racks	N/A
Forceps	N/A
Pipette Pump	N/A
Micropipettes	N/A
Magnetic Funnels with 47 mm bases, 500 mL	N/A
Vacuum Filtration Manifold	N/A
Autoclave	S/N 031761851
Fisher Mini Vortexer	N/A
Fisher Minicentrifuge	N/A
Megafuge ST4RF Plus-MD Centrifuge	S/N 43126247
Blue LED light manifold	N/A
PCR #9, Thermo Refrigerator Isotemp	S/N TR1562211012; Maintained at 4 ± 2°C, Room B246A

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PCR #2, Thermo Freezer	S/N 0121174101121218; Maintained at -20 ± 10°C, Room B246A
PCR#10, Thermo TDE Freezer	S/N 1127920701221013; Maintained at -80 ±10°C, Room B246

3.2. Supplies and Consumables –

Supply Name
Gloves, Latex or Nitriles
50 mL Centrifuge Tubes
Microcentrifuge Tubes, 0.5, 1.5, and 2.0 mL
Polycarbonate Membrane Filter, 47-mm Diameter, 0.45 µm Pore Size
Glass Fiber Filter, 47 mm Diameter, AP20
Sterile Disposable 50 mL Tips
Sterile PCR Grade Filter Tips
Petri Dishes, 47 mm, sterilized, with rimmed lid
Qiagen DNeasy PowerSoil Pro Kit

4. REAGENTS AND STANDARDS

4.1. Reagents and Standards –

Reagent/Standard Name	Notes
Deionized (DI) Water	N/A
Molecular Biology Grade Water	Corning Molecular Biology Grade Water tested to USP Sterile Water (Catalog Number: MT46000CV)
Bleach Solution, 10% (v/v)	Prepare per SOP BG-05
Phosphate Buffered Saline (PBS)	Prepare per SOP PCR-3.0
TE Buffer	Catalog Number: BP2473
Ethanol, 80% (v/v)	N/A

5. DIMETHYL SULFOXIDE (DMSO) PREPERATION

5.1. 20% DMSO – Prepare fresh 20% DMSO every time 20 mM stock PMA is made. DMSO is diluted to 20% DMSO (v/v) before use.

DMSO	200 µL
PCR Grade Water	800 µL

In a 2 mL microcentrifuge tube containing 800 µL of PCR grade water, add 200 µL of DMSO. Mix well by vortexing.

5.2. Record purchased DMSO and the working stock in LIMS Standard Preparation Tracker Module (**Laboratory/Technical/Standard Preparation Tracker**). Choose **BIO-PCR** from the "Group" drop down list.

5.2.1. For DMSO Purchased Reagent: Select **Purchased/New Reagent/Material** from the menu. If a similar reagent record exists, select **Purchased/Duplicate Reagent/ Material** from the menu and choose the reagent to duplicate from the list.

Identity	Dimethyl Sulfoxide (DMSO)
Description	Solvent used to dissolve PMA dye
Entered By	Analyst Name
Type	Solvent
Grade	A.C.S. Grade

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Purity	Blank
Received Date	Date of Receipt
Expires	Date of expiration if on the bottle
Has Certificate of Analysis	Yes
Manufacturer	MP Biomedicals
Lot Number	From the Bottle
Storage Location	B212
Additional Information	Stored in desiccator
Storage Temperature	Room Temperature
Container Size	100
Units	mL

5.2.2. For 20% DMSO Working Stock: Select **Prepared/New Reagent** from the menu. If a similar reagent record exists, select **Prepared/Duplicate Reagent** from the menu and choose the reagent to duplicate from the list.

Identity	20% Dimethyl Sulfoxide
Type	Working Reagent
Holding Time	180 days
Entered By	Analyst Name
Prepared	Date/Time of preparation and Analyst Name
Location	B246A
Storage Temperature	Room Temperature
SOP	PCR-1.1
Description	Solvent for making PMA dye
Solvent Used	Water
Final Volume	1000
Units	µL

5.2.2.1. Click Add. In the "Enter Serial #" pop up window, choose the purchased reagent from the list, or enter its serial number in the text box. Click OK. In the "Enter Amount & Units for.." pop up window, enter "200 as Vol/Wt added" and "Units in µL". Click OK.

6. PMA DYE PREPARATION

NOTE: PMA is a photoreactive dye and must be worked with in darkness. Turn off the lights of the room and line the glass door with either black trash bags or aluminum foil. If needed, a red light can be used during preparation.

6.1. PMA (stock concentration 20 mM) –

20% DMSO	98 µL
PMS Dye	1 Vial

6.1.1. PMA powder is stored in a cardboard box at 4ºC in Room B246B. Remove the PMA dye vial from 4ºC. Centrifuge to collect the powder dye at the bottom of the vial at ~7000 rpm for 30 sec.

6.1.2. Add 98 µL of 20% DMSO to the PMA dye vial to make a 20 mM stock.

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6.1.3. Mix well by vortexing for 10 minutes at speed 6. Centrifuge briefly to coalesce drops.

6.1.4. Aliquot 25 µL of PMA in 0.5 mL microcentrifuge tubes.

NOTE: The remaining dye in the tube should be discarded. Aliquots are single use only.

6.2. Record purchased and the stock PMA in LIMS Standard Preparation Tracker Module (Laboratory/Technical/Standard Preparation Tracker). Choose BIO-PCR from the "Group" drop down list.

6.2.1. For PMA Purchased Reagent: **Select Purchased/New Reagent/Material** from the menu. If a similar reagent record exists, select **Purchased/Duplicate Reagent/Material** from the menu and choose the reagent to duplicate from the list.

Identity	Propidium Monoazide (PMA)
Description	Photoreactive DNA binding dye
Entered By	Analyst Name
Type	Powder
Grade	HPLC Grade
Purity	Blank
Received Date	Date of Receipt
Expires	Per Manufacturer Specification
Has Certificate of Analysis	Yes
Manufacturer	Biotium
Lot Number	From the Bottle
Storage Location	246B
Additional Information	None
Storage Temperature	Refrigeration at 4°C
Container Size	1
Units	mg

6.2.2. For PMA Stock: Select **Prepared/New Reagent** from the menu. If a similar reagent record exists, then select **Prepared/Duplicate Reagent** from the menu and choose the reagent to duplicate from the list.

Identity	20 mM PMA Dye
Type	Stock Reagent
Holding Time	180 days
Entered By	Analyst Name
Prepared	Date/Time of preparation and Analyst Name
Location	B246A
Storage Temperature	Freezer <-10°C
SOP	PCR-1.1
Description	PMA DNA binding dye
Additional Information	Dissolved in 20% DMSO
Solvent Used	Water
Final Volume	100
Units	µL

6.2.2.1. Click Add. In the "Enter Serial #" pop up window, choose the purchased reagent from the list, or enter its serial number in the

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text box. Click OK. Click Add again and choose 20% DMSO from the prepared list. In the "Enter Amount & Units for." pop up window, enter "98 as Vol/Wt added" and "Units in µL". Click OK.

6.2.3. Click OK to save the entry and receive a serial number. Open the Brady Workstation software and create labels (see SOP PCR-5.0 for details). Print labels with the reagent name (20 mM PMA), serial number, and expiration date and affix labels to the side of each tube. The top label should include the reagent name. Place labels on all aliquoted tubes before storage at -20°C.

6.3. Working PMA Reagent (100µmol) –

20 mM PMA Stock	(Number of treated filters +2)*1.5µL
Phosphate Buffered Saline (PBS)	(Number of treated filters +2)*298.5µL

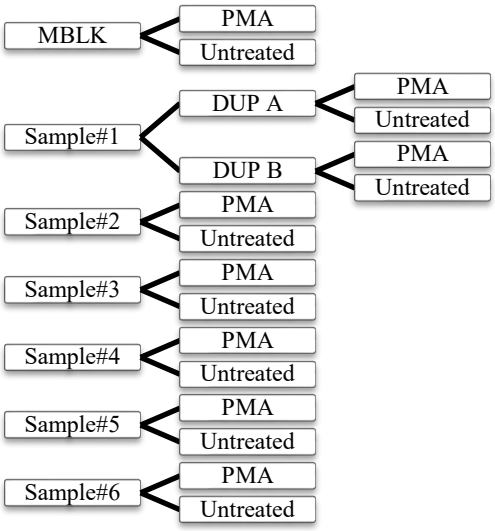
In a darkened room, make a 100 µmol working concentration of PMA. 300 µL of working reagent is needed per PMA-treated filter. To ensure there is enough working reagent, count the number of treated filters and add two. Use this number to calculate the amount of PMA stock and PBS needed.

6.3.1. Example: If the number of treated filters is eight, add (8+2)*1.5= 15 µL of PMA stock and (8+2)*298.5= 2985 µL of PBS to a centrifuge tube. This will create 3000 µL of a 100 µmol working reagent.

6.3.2. Mix the reagent well and use the day of.

7. SAMPLE PREPARATION AND PMA TREATMENT

7.1. Using the guide below, prepare enough petri dishes for the batch. Label the dishes with the sample ID and either 'PMA' or 'untreated'.



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7.2. Filter 50-200 mL of water sample per SOP PCR 4.0. The volume filtered is determined by water turbidity and the number of filters needed for other analyses. Collect two filters per sample, one for PMA treatment to determine live cells and one PMA-untreated filter to represent total cells.

7.2.1. For samples serving as duplicates, always filter 100 mL and collect four filters total, two for PMA treatment and two for untreated. If samples are scheduled for both PMA and crude assays, select a different sample than the duplicate for the crude batch.

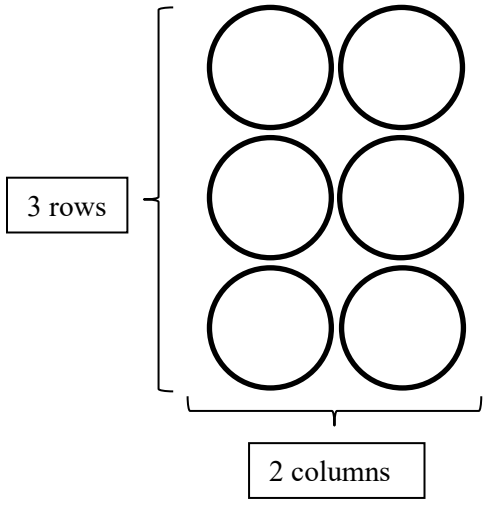
7.3. Add a drop of PBS to the petri dishes. Using forceps, transfer the two collected filters to the corresponding dish. Make sure the filter is smooth and flat.

7.4. Working in the darkened room, add 300 µL of PMA working reagent to each PMA-treated filter, covering it completely. For the untreated filters, add 300 µL of PBS as a control.

7.5. Incubate the filters in the dark for 20 minutes with occasional gentle mixing to ensure entire filter remains in contact with the dye.

7.6. Expose filters to light by placing the petri dish under the LED lights in the manifold for 15 minutes. Remove the lids of the petri dishes before turning on the light.

7.6.1. To maximize the amount of petri dishes able to be exposed to light at the same time, arrange the dishes into three rows of two dishes. Multiple rounds of treatment may need to be performed to treat all filters for the batch.



7.6.2. Duplicate filters should be treated in the same light batch.

7.7. Aseptically fold the filters in the petri dishes and then place them in bead tubes from the Qiagen DNeasy PowerSoil Pro kit. Proceed with DNA purification or freeze the filters at -80ºC until analysis.

7.8. Add samples and filtration information in Prep Worksheet Manager. PMA samples have the Test ID PMA-HF183 and the components HF183-PMA treated-

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qPCR and HF183-purified-untreated-qPCR. All samples are scheduled for both components and are added to worksheet type SOP-PCR-1.1.

7.8.1. Add up to 6 samples per worksheet. Duplicate each line and add _PUR to one of the lines for each sample. This will serve as the untreated control. The line with the sample ID alone represents the PMA treated filter.

7.8.2. Choose one sample to serve as the duplicate for the worksheet. This sample will have 4 lines total: _DUP_A_PUR, _DUP_A, _DUP_B_PUR, and _DUP_B.

7.8.3. After filtration, input the filtration date/time and volume. Include the LIMS ID for the PBS in Reagent 1 and the PMA dye in Reagent 2.

NOTE: Keep forceps in a small beaker of ethanol during the filtration and incubation process. Dip in the ethanol and shake off excess before grasping each filter. If forceps are accidentally dropped or placed on counter, replace with a new pair of sterile forceps from the UV sterilizer.

8. DNA PURIFICATION

8.1. Purify total genomic DNA from filters using the Qiagen DNeasy PowerSoil Pro kit as per SOP 4.2.

8.2. Freeze extracts at -20º C until analysis.

9. SAMPLE ANALYSIS

9.1. Refer to SOP PCR-3.2 for reagent preparation and SOP PCR-1.0 for HF183 qPCR sample analysis. For PMA plates, the Target Name for the HF183 primers and probe in the StepOne/QuantStudio3 file is PMAHF. The spikes and standards are the same as in PCR-1.0, and the extraction control (EC) and purified (untreated control) samples have the purified nomenclature.

10. QUALITY CONTROL

10.1. Analyze a method blank (MB) for PMA treatment and one for PMA untreated with the batch.

10.2. Analyze an extraction blank (EB) by placing a sterile filter in a bead tube and extracting it with the batch.

10.3. Analyze an extraction control (EC) by placing a sterile filter in a Qiagen bead tube, spiking in 5 µL of the 10^6 HFG2GD gBlock and purifying with the batch. This will be analyzed on the reaction plate to quantify recovery. Only one EC is required for PMA worksheets, as no other markers will be analyzed for these samples.

11. SAFETY/ HAZARDOUS WASTE MANAGEMENT

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11.1. For sample filtration, purification, and analysis, wear safety glasses, gloves, and a clean disposable lab coat. If any substance falls on the gloves during processing, change into a new pair immediately to prevent any possible contamination of samples or controls.

11.2. All media/bacteria/plates must be autoclaved for 45 minutes before disposal.

11.3. Refer to the Laboratory Health and Safety Manual and Hazardous Waste Management. Read MSDS information for reagent handling and disposal.

12. REFERENCES

12.1. DEP Laboratory Quality Manual

12.2. Health and Safety Plan

12.3. DEP SOP PCR-1.0, *Human-Associated Bacteroidales HF183 Marker in Water by Quantitative Polymerase Chain Reaction (qPCR) Assay*

12.4. DEP SOP PCR-3.0, *Preparation of Reagents for quantitative Polymerase Chain Reaction (qPCR)*

12.5. DEP SOP PCR-3.2, *Preparation of HF-183 Assay Reagents and Standards for qPCR analysis*

12.6. DEP SOP PCR-4.0, *Preparation of samples for qPCR*

12.7. DEP SOP PCR-4.2, *Purification of Filtered Samples using the Qiagen DNeasy PowerSoil Pro Kit*

12.8. DEP SOP PCR-5.0, *Sample Custody, Preparation Labels, and Worksheet Instructions for Molecular Biology*

12.9. Biotium/ PMA product information

Appendix of Significant Changes

12/17/2020	Edited formatting
11/29/2021	Made changes from B. dorei genomic DNA to HFG2GD gBlock.
12/06/2022	Changed -80ºC freezer and +4 ºC refrigerator information.
11/16/2023	Edited formatting. Increase aliquot volume for PMA dye. Added a method blank for untreated
10/22/2024	Reformatted sections 6 and 7 and added guides to help clarify PMA procedure.

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