National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Impact of Emission Control Technologies and Fuel Type on the Oxidative and Inflammatory Potential of Engine Exhaust Particles

Gerlofs-Nijland, Totlandsdal, Bønløkke, Ntziachristos et al., manuscript in preparation

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Background

- Link between traffic-related particulate matter (PM) and adverse human health effects
- Health effects of emissions using different fuel types and/or new emission control technologies less investigated
- Focus on emission reduction to meet the standard
- Current study examined oxidative and inflammatory potential using a 50% v/v biodiesel (B50) blend and/or a diesel particle filter (DPF)

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Study design

- Toxicity characterisation of engine exhaust with two fuel types with or without DPF
- Pure fossil diesel (EN590:2009) and 50% volume blend with Rapeseed Methyl Ester (RME; EN14214)
- Driving cycles to simulate urban or rural driving conditions
- Sampling directly from the dilution tunnel (constant volume sampling CVS) on teflon-coated glass fiber filters with high volume sampler (HVS)
- Particle collection (methanol extraction) and toxicity testing (inflammation, cytotoxicity, oxidative stress)

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Sampling engine emission
Test vehicle and main specifications

Honda Accord 2.2i-CTDi
Engine: 4 cyl., Common rail, Direct injection
Engine Capacity: 2200cc
Engine Power: 100 kW
Pollution control: EGR,
Oxidation pre-catalyst, 2-stage DOC with
DeNOx characteristics ("4-way catalyst"), DPF
Gearbox: Manual
Certification: Euro 4
Mileage: 79599 km

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Sampling engine emission
Impact emission control technology and fuel

Sample code	DPF	Fuel	Cycles	Mass (mg)	Emission rate (mg/km)
B0 urban	no	diesel	1x UDC + 2x Artemis urban	24,30	46,10
B0 rural	no	diesel	1x EUDC + 1x Artemis road	28,18	29,72
B50 urban	no	biodiesel blend	1x UDC + 2x Artemis urban	13,52	25,76
B50 rural	no	biodiesel blend	1x EUDC + 1x Artemis road	12,68	13,37
B0 urban	yes	diesel	1x UDC + 9x Artemis Urban	3,82	0,61
B0 rural	yes	diesel	4x EUDC + 4x Artemis Road	3,58	0,42
B50 urban	yes	biodiesel blend	1x UDC + 9x Artemis Urban	1,58	1,47
B50 rural	yes	biodiesel blend	4x EUDC + 4x Artemis Road	2,25	0,67

- Diesel particle trap (DPF) reduction PM emission
- Biodiesel (B50) reduction PM emission

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Toxicity testing

- Oxidative potential (to predict toxicity)
  - DTT: consumption
  - Ascorbic acid (AA): consumption rate in time

- Cytotoxicity

- Inflammation
  - human bronchial epithelial cell line (IL-6, IL-8)
  - whole blood assay (IL-6, IL-8, TNF-α etc.)

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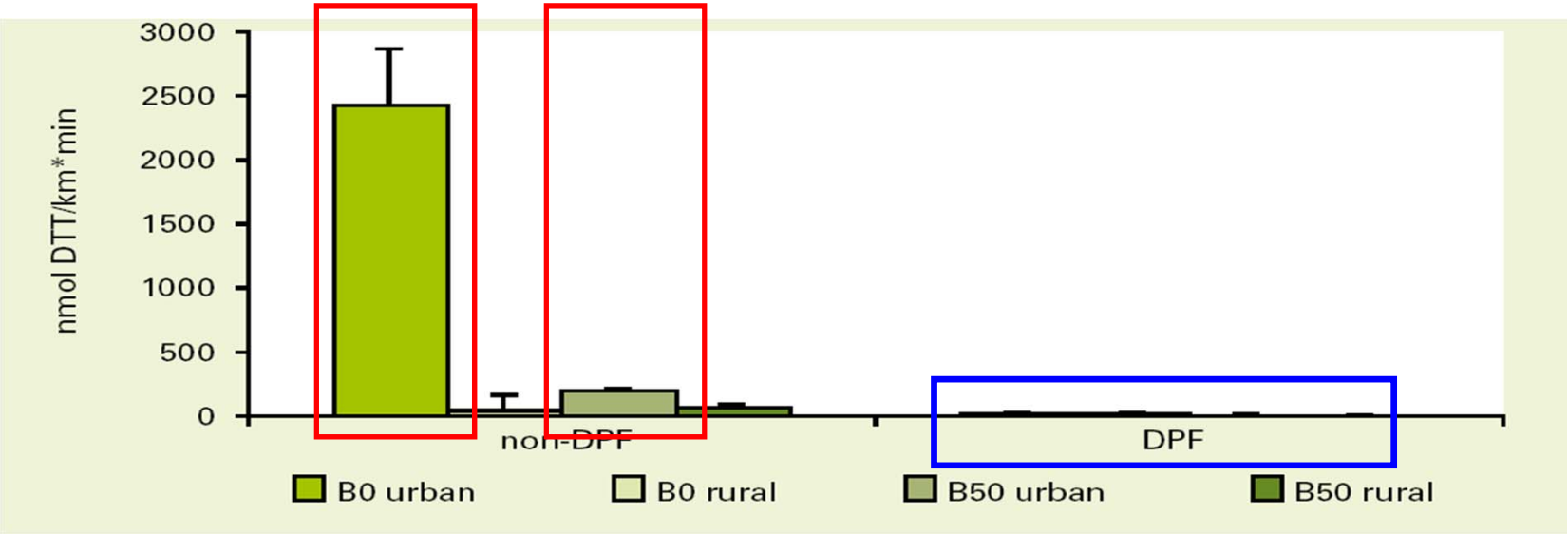
Oxidative potential (to predict toxicity)



- Biodiesel (B50) reduction oxidative potential
- Beneficial effect for DPF
- Expression outcomes per kilometre more relevant for risk assessment

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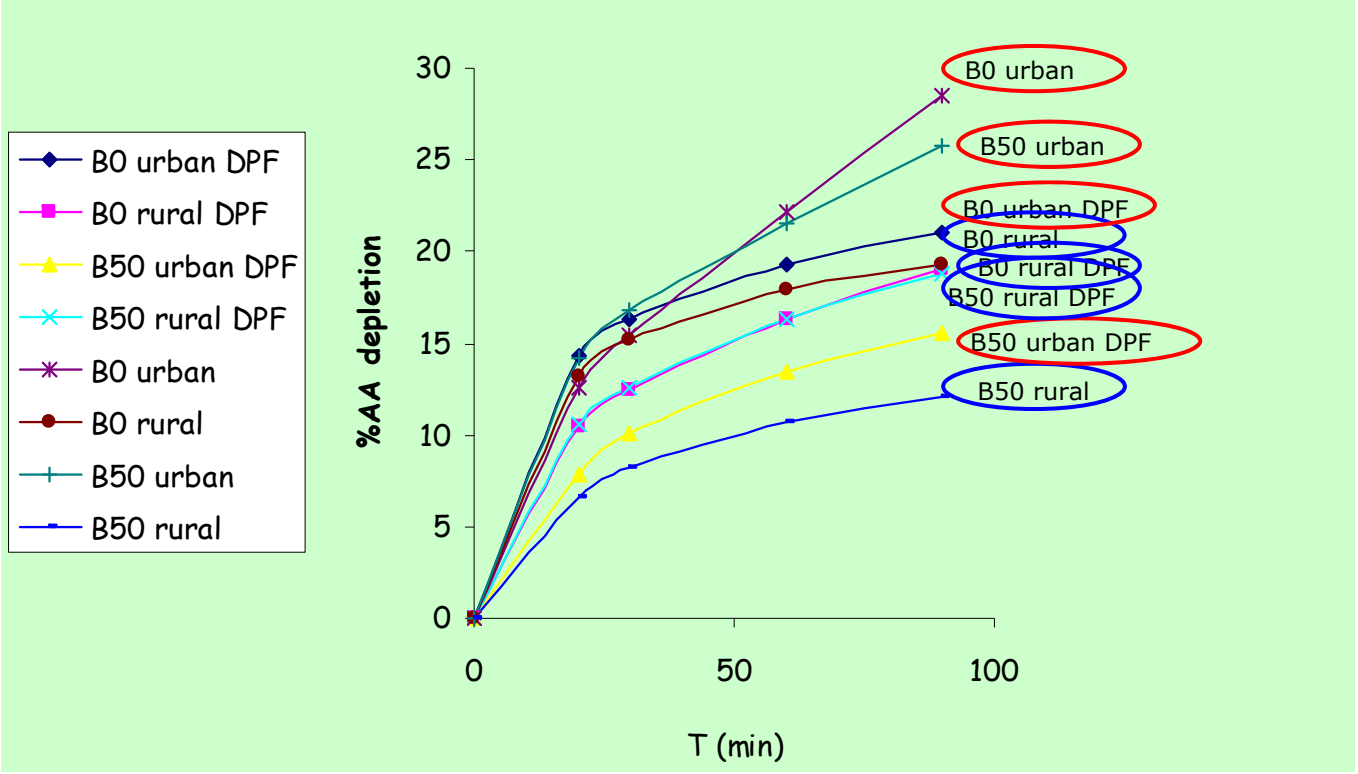
Oxidative potential – ascorbate assay



- Biodiesel (B50) reduction oxidative potential
- In general beneficial effect DPF only for urban conditions
- Rural conditions no influence of fuel if DPF applied

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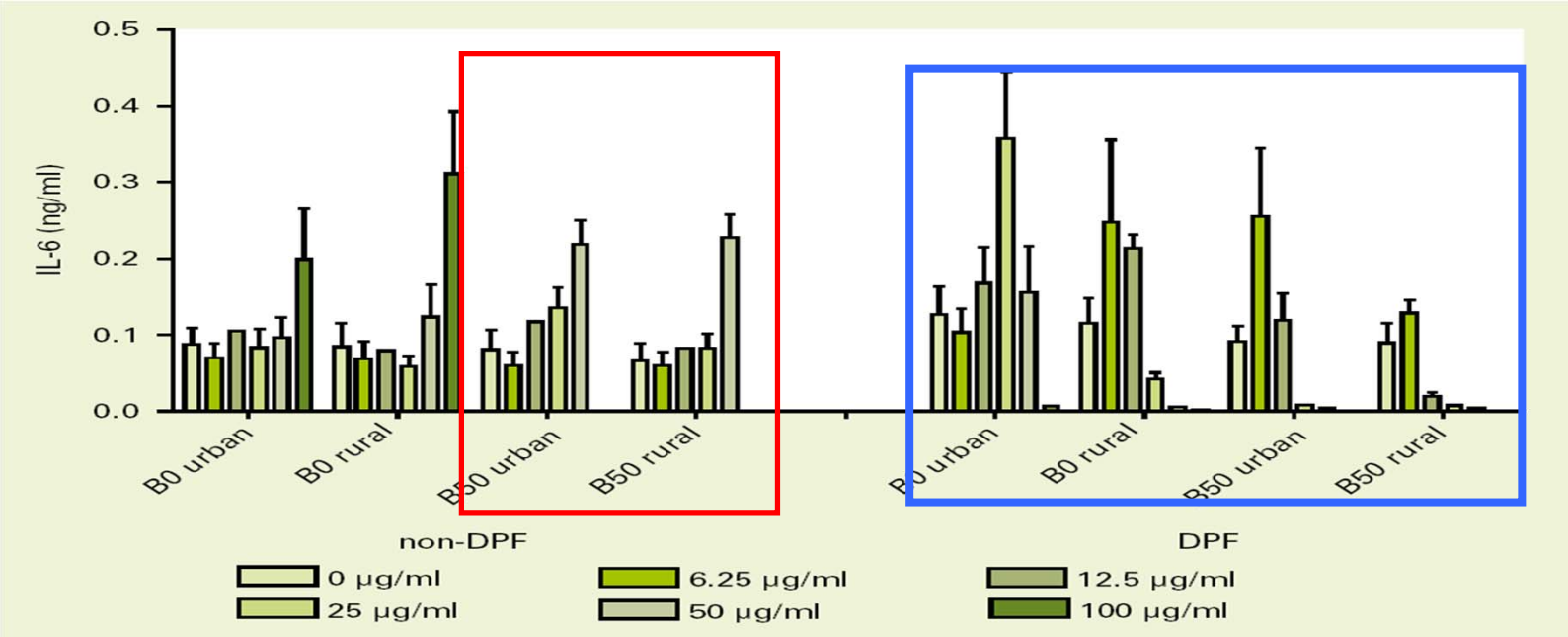
"Inflammation in the lungs"



- Biodiesel (B50) increase inflammatory response (per mass)
- DPF no beneficial effect (per mass)

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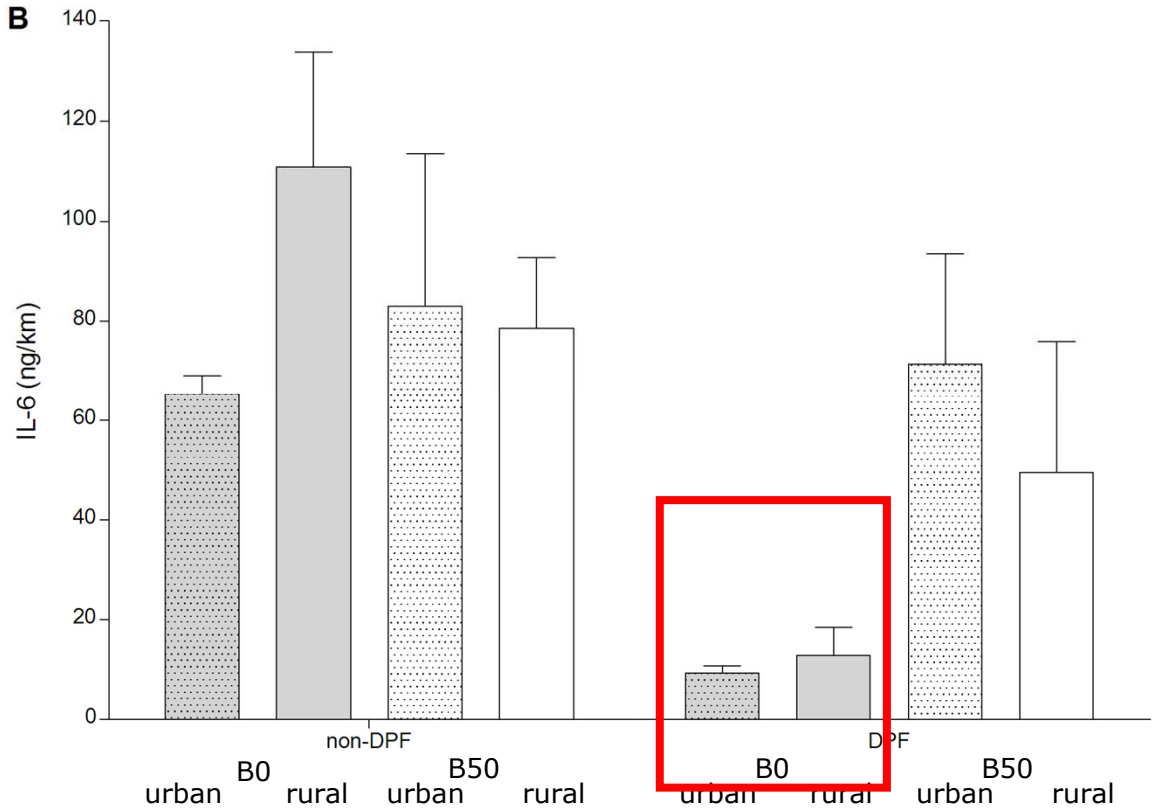
"Inflammation in the lungs"



- DPF beneficial effect (mainly for diesel)

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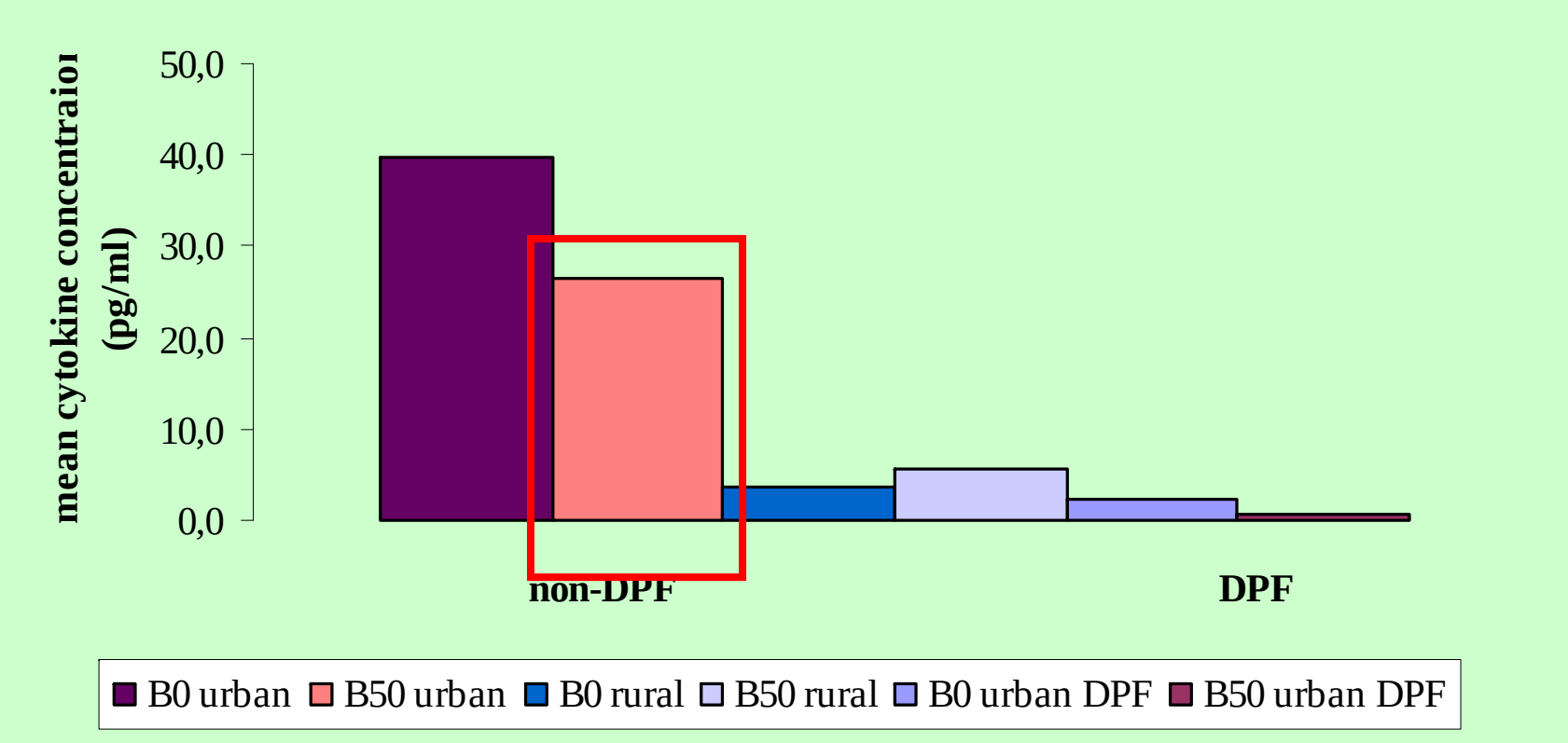
"Inflammation in systemic system"



- Biodiesel (B50) reduction inflammatory response

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Summary

- Biodiesel
  - reduction of oxidative potential
  - increased inflammatory response in the lung
  - reduced inflammatory response in sytemic system

- DPF
  - overall beneficial effect
  - also for inflammatory response in the lung, however, mainly for diesel and only when expressed per km

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SETPOINT

- Screening Emissions for Toxic Potential –Organizing INTernational harmonization
- Network to facilitate knowledge transfer
- Design and establish an international harmonised test approach for toxicity testing of engine emissions
- Critical evaluation of new developments to be able to compare results and to put new products or technology in perspective

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