

Bioaerosols in Colorado Dairies

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Introduction

- Organic Dusts – bioactive
 - Suggested OEL 2.4 mg/m³ total dust much lower than “nuisance dust” TLV 10 mg/m³ or grain dust TLV 4 mg/m³
- Rich ecosystem – bacteria, fungi,
 - plant/insect/animal derived material
- Focus on bacteria and endotoxin

Dairy Industry

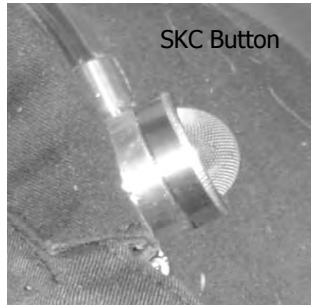
- Rapidly changing in the U.S. with growth of much larger operations in the West, including an influx of European firms.
- In 2004 Colorado had 679 operations, with 102,000 head of milking cows, producing 2.2 billion pounds of milk. Region VIII had 3,730 operations with 326.3 million head of cows.
- More than 90% of the workforce in Colorado and other regional Dairies is Hispanic, often speaking little English.
- Pollutants of Concern
 - n PM10 (<10 microns)
 - n PM2.5 (<2.5 microns)
 - n Ammonia (PM precursor)
 - n Volatile organic compounds (VOC, ozone precursor)
 - n Hydrogen Sulfides (H₂S)
 - n Methane (“greenhouse” gas)
 - n NO_x (Oxides of Nitrogen, ozone precursor)

Dairy Industry

- Public Perception

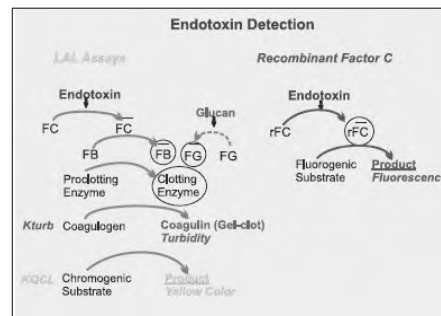
In the past three years, Central Valley residents calling air pollution “a big problem” has risen from 28 to 42%
Statewide 47% of residents support “tougher regulations of agriculture and farm activities even if they create greater operational costs”
- Public Policy Institute, 2003

Occupational Samplers



rFC Assay

- Recombinant Factor C (rFC) assay
- measures the relative reactivity of endotoxins with an enzyme

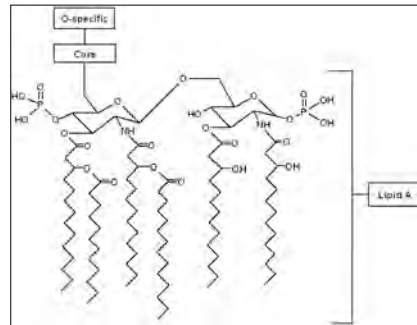


(NOAA, 2007)

(Cambrex inc., 2003)

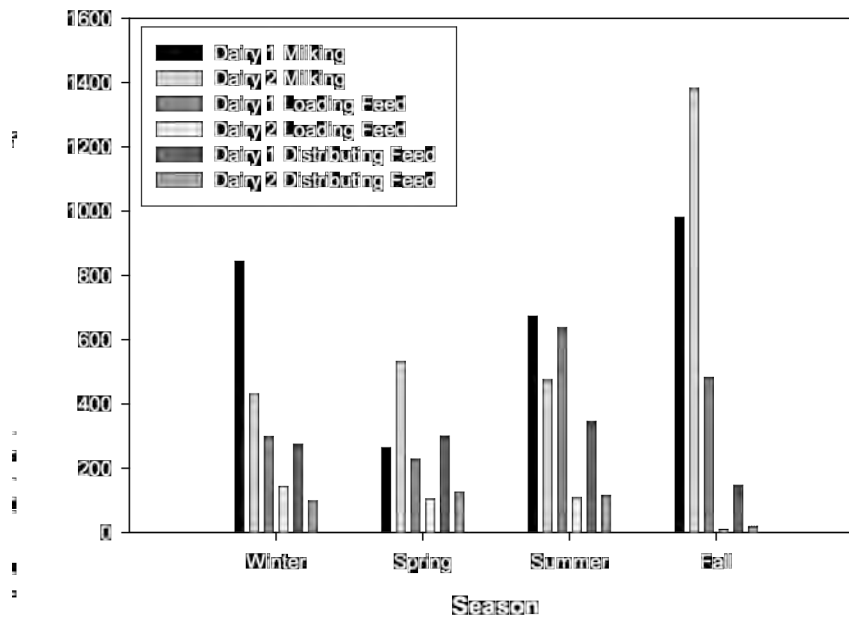
GC/MS Analysis

- Focus on quantification of biomarker of endotoxin
 - 3-hydroxy fatty acids (3-OHFAs) with 8 to 18 carbon chain lengths in lipid A

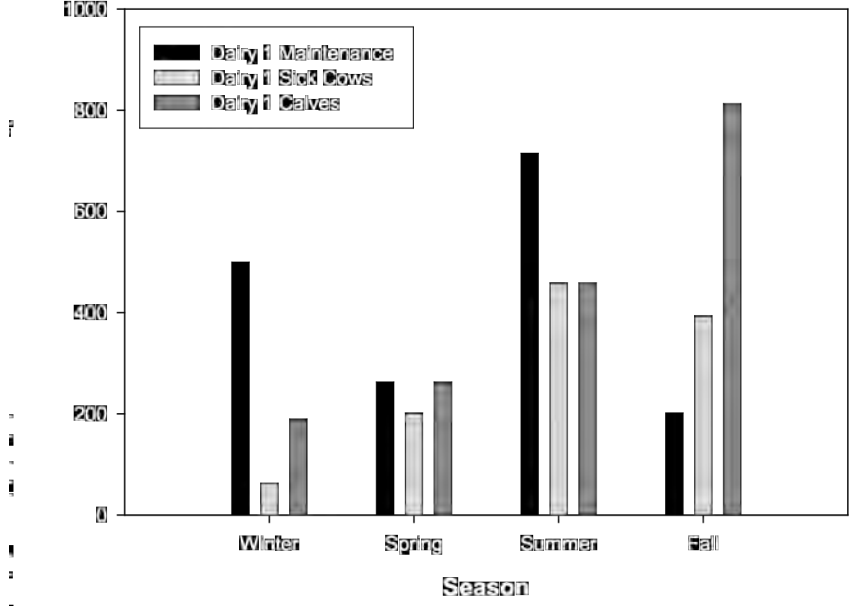


(Saito, 2008)

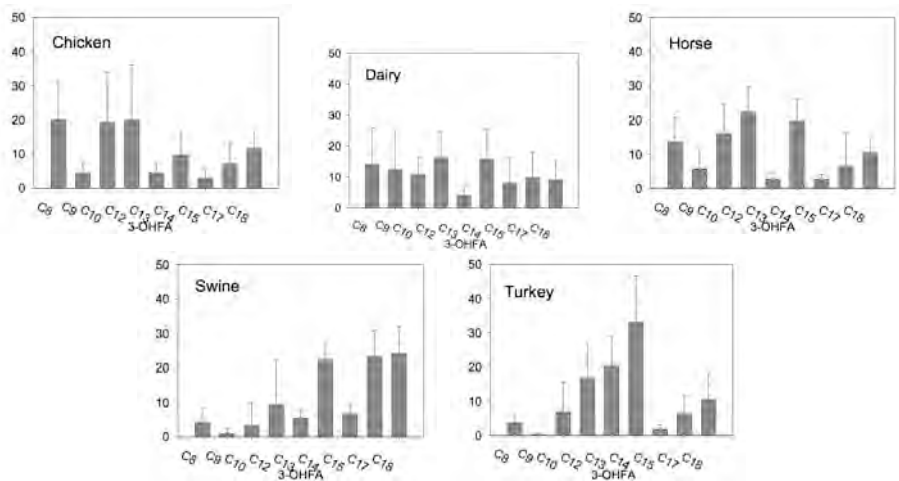
Inhalable Endotoxin Tasks



Inhalable Endotoxin Tasks



3-OHFA Proportions



GC/MS, Immune Markers and PFT Changes

- 12, 14, 18 3OHFAs correlate with decrease in FVC and FEV1 ($r = 0.17$ to 0.24)
- Even chain 3OHFAs (pg/mg) associated with increased PMN, MPO, Albumin, ECP in nasal lavage (not odd chains).

Bioaerosols Samplers



Culturable Bioaerosols Respirable and Non-Respirable

Source, Microorganism	Site					
	Respirable (PM10-2.5)			Non-Respirable (PM10-2.5)		
	min	max	av	min	max	av
Field						
Manure	###	[#.#]		###	[#.#]	
Manure-respirable	###	[#.#]		###	[#.#]	
Manure!	###	[#.#]		###	[#.#]	
Stables						
Manure	###	[#.#]		###	[#.#]	
Manure-respirable	###	[#.#]		###	[#.#]	
Manure!	###	[#.#]		###	[#.#]	
Hay						
Manure	###	[#.#]		###	[#.#]	
Manure-respirable	###	[#.#]		###	[#.#]	
Manure!	###	[#.#]		###	[#.#]	
Barren						
Manure	###	[#.#]		###	[#.#]	
Manure-respirable	###	[#.#]		###	[#.#]	
Manure!	###	[#.#]		###	[#.#]	
Soil						
Manure	###	[#.#]		###	[#.#]	
Manure-respirable	###	[#.#]		###	[#.#]	
Manure!	###	[#.#]		###	[#.#]	

QUESTIONS:

- What is the diversity of bioaerosols in agriculture?
- Do barns, free stalls and milking parlors present different challenges in sampling for bioaerosols?
- How does timing of sampling influence bioaerosol detection?
- Microbial sampling and culturing approaches?
- Sampling methods – which is best?
- How does feed preparation influence monitoring strategies?
- Animal activity, diurnal fluctuations, plumes, dried manure in free stalls

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