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Airborne Bacterial Exposure at Workers' Breathing Height in an Organic Farm of Rural Georgia

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Introduction

Organic farming has potentials to contribute substantially to the future sustainable agricultural production by improving soil quality, pest control, and reduction of adverse environmental impacts in rural agricultural communities. On the other hand, application of natural farmyard manure may increase the microbial biomass in this environment, and consequently the microbial exposure levels among workers. To explore this possibility of excess exposure, particularly to airborne bacteria, we conducted air sampling and testing at the vicinity of poultry and dairy sections of a large organic farm in a rural Georgia location. The purpose of this study was to evaluate occupational exposure to microbial elements in a farming working environment.

Methods

- **Three different locations of air sampling**
  - Chicken coop, Cow pasture, and Pig pasture in a large organic farm in rural Georgia.
- **Sampling period**
  - Three consecutive weeks.
  - Each sampling period devoted to one location.
  - Each location sampled through an entire day.
  - 3 samples each from morning, afternoon, and evening time.
- **Sampling methods**
  - Samples were taken at workers' breathing height of 1.5 m for 10 minutes at a time. Before each sample was taken, the humidity, temperature and wind speed was recorded.
  - Two sampling methods were used during this study: Active air sampling and dust swabbing for ATP levels.
  - The collection method for all three of these location consisted of using the same materials, equipment and sampling methods.
- **Equipment**
  - Biostage viable cascade impactor
  - Inlet cone, precision-drilled 400-hole impactor stage, and a base that holds a standard-size agar plate.
  - Tryptic soy agar and Male extract agar media were used for sampling of airborne bacteria and fungi.
  - A high flow QuickTake 30 pump connected to this impactor pulls microorganisms in air at 28.3 L/min flow rate through the holes (jets) where they were collected on the agar surface.
  - ATP in dust samples were monitored by a standard kit and a luminometer
  - Anemometer equipped to a weather station was used to measure wind speed, temperature, and humidity.
- **Analysis of samples**
  - Colonies on agar plates were counted and converted to airborne concentrations
  - ATP in dust samples were measured as relative light units (RLU)
  - Most abundant fungal colonies were identified by high-resolution light microscopy
  - Bacterial colonies were identified by PCR amplicon sequencing of 16S rRNA genes and nucleotide BLAST (BLASTn) was used to determine sequence homology. Sequence match (>99% sequence similarity) was used to identify bacterial strain.

Results

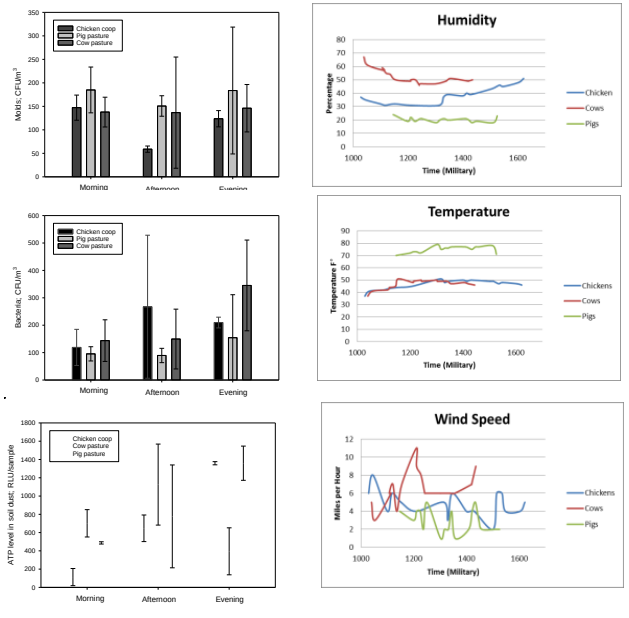

Fig. 1. Variations (means and standard deviations) of culturable molds, bacteria, and ATP levels in three sampling locations .

Fig. 2. Variations of wind speed, temperature, and relative humidity in three sampling locations .

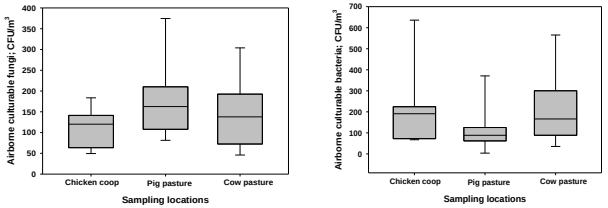

Fig. 3. Box plots showing overall culturable mold and bacterial levels in three sampling locations. The lower and upper boundaries of the box specify the 25th and 75th percentiles, respectively. The line within the box indicates the median and the whiskers above and below the box indicate the 95th and 5th percentiles, respectively.

Sample ID	Name of molds
Chicken coop	*Aspergillus* sp.
	Penicillium sp.
	Cladosporium sp.
Cow pasture	*Aspergillus* sp.
	Penicillium sp.
	Nonsporulating colonies
Pig pasture	*Penicillium* sp.
	Nonsporulating colonies
	Aspergillus sp.

Table 1. Common airborne molds identified in three locations.

Sample ID	Name of bacteria
Chicken coop	*Pseudomonas* sp.
	Bacillus sp.
	uncultured organism clone SBYO
Cow pasture	*Pseudomonas putida*
	Stenotraphomonas rhizophila
	Stenotraphomonas maltophilia
Pig pasture	*Bacillus subtilis*
	Brevundimonas sp.
	Pseudomonas chlororaphis

Table 2. Common airborne bacteria identified in three locations.

Summary of results:

- Airborne bacterial concentrations were generally higher than mold concentrations in three farm locations
- Average culturable microbial concentrations in three locations were not significantly different but diurnal variations for bacteria and fungi and microbial activity (ATP levels) during morning, afternoon, and evening were different.
- Airborne microbial genera in three locations were different from each other.

Significance

The significance of this study on public health is that across the United States the agriculture industry employs nearly three quarters of a million people. Within this line of work individuals encounter many health hazards ranging from the chemicals that are used to produce crops to the actual physical labor necessary to harvest produce. This study is important in drawing information directed at what kind of mold and bacteria exposure happen when no synthetic chemicals are used. This study was conducted in an organic , free-range, cattle farm, producing livestock without the presence of synthetic chemicals. The weakness of the study is its small sample size.

Conclusion

Throughout the sampling period there were observable differences between the time of the day and culturable mold and bacterial concentrations and changes in dust ATP levels at all three sampling locations. This observation indicates that workers in this type of organic farms can be exposed to different levels of microorganisms at different work hours. The preliminary data showed that bacterial levels in these work environments are slightly lower during morning hours, but mold levels are overall consistent during the whole day.

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