Monitoring Airborne Microorganisms During Food and Beverage Processing

Comparison of four microbial air samplers

Air monitoring is a GMP requirement in the United States and Europe. It is also an important part of many HACCP compliance programs.

Air monitoring provides information on the quality of the processing environment during manufacturing and enables the study of microbiological air quality trends (Figure 1).

There are two basic methods of air monitoring: passive and active. Passive monitoring, such as the use of settling plates, can only detect microorganisms that fall onto the surface of the medium. Active air sampling systems draw a volume of air from the test area and, therefore, provide a more representative sample.

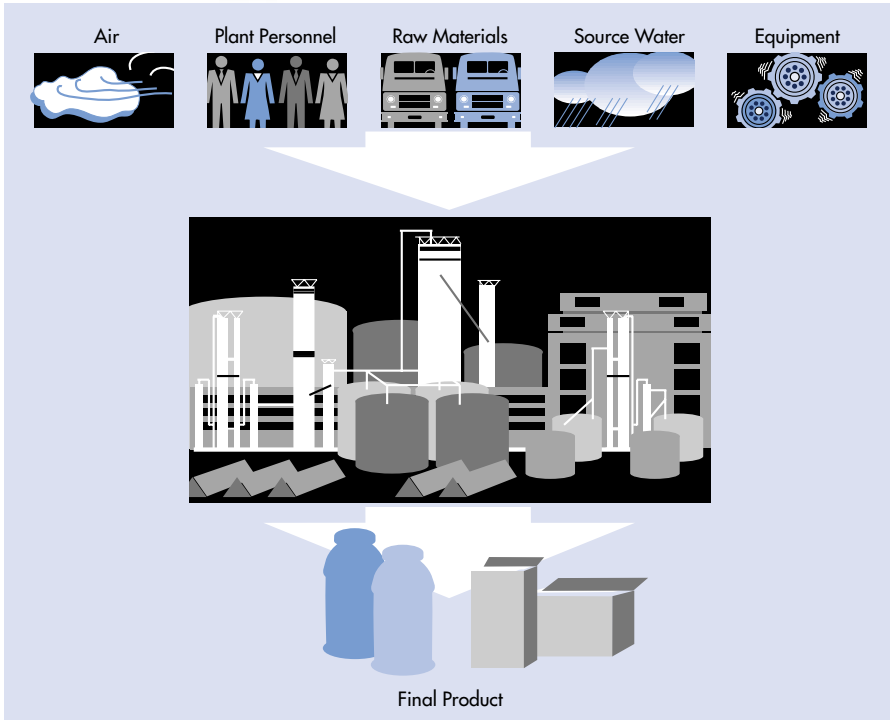

Figure 1. Air is one of the five primary sources of particulate and microbial contamination.

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The purpose of this study was to compare the performance of a new, active microbial air sampler (M Air T), to a Slit-to-Agar (STA) sampler and two other widely used air samplers. The M Air T System uses the seive-impaction sampling method (Figure 2).

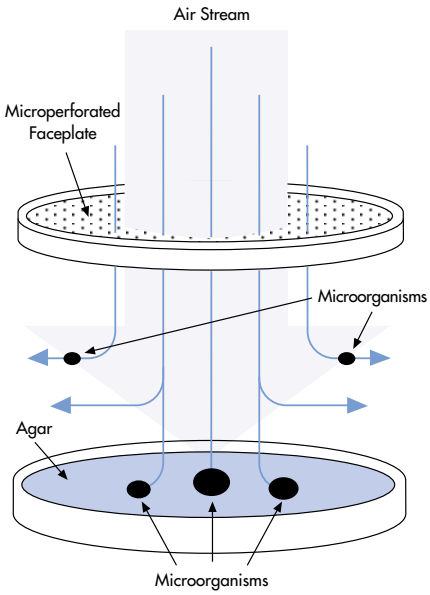


Figure 2. The seive-impaction sampling method.

Materials

- Four active microbiological air samplers were selected for evaluation (refer to Table 1 for operating parameters).
  - –M Air T Air Tester (Millipore Corporation, Bedford, MA)
  - –RCS PLUS Air Sampler (Biotest Diagnostics, Denville, NJ)
  - –RCS High Flow Air Sampler (Biotest Diagnostics, Denville, NJ)
  - –Slit to Agar Biological Air Sampler, STA 203 (New Brunswick Scientific Co., Edison, NJ)
- Air Current Tubes (Drager, Sicherheitstechnik, Germany)
- Recovery agar was standard Soybean Casein Digest Agar (also known as Tryptic Soy Agar or TSA). Multiple lots of cassettes, strips, and dishes were used.
  - –M Air T TSA Cassettes for M Air T (Millipore Corporation, Bedford, MA)
  - –Biotest TSA Test Strips for RCS PLUS and High Flow (Biotest Diagnostics, Denville, NJ)
  - –TSA dehydrated powder reconstituted and sterilized according to manufacturer's instructions at 65 mL per 150 mm Petri dish for STA 203 (Difco, Detroit, MI)

Method

A two-factor, four-level, full-factorial blocked design was used for this study. The factors were Air Tester (M Air T, RCS PLUS, RCS High Flow, STA) and Test Position (P1, P2, P3, P4). The four samplers were tested simultaneously as a group. After all samplers completed sampling 1 m^3 (1,000 L) of air, the samplers were switched for test position. One test block consisted of all air samplers tested in all test positions for a total of 16 tests in four groups. Six test blocks were completed in a single experiment for a total of 96 tests in 16 groups.

Five experiments each were conducted in a controlled-access, but unclassified, testing room (room volume 87 m^3). All samplers were placed at least 1 m from the ceiling and 1 m from each other. While the samplers operated simultaneously, their orientation was tested for exhaust turbulence and other potential air current disturbances using Drager air current tubes.

All TSA agar plates, cassettes, and strips were weighed before and after testing. All agar was incubated in humidified environments for 48 hours at 35 °C followed by 72 hours at 25 °C. Samples from the unclassified test room were enumerated at both 48 and 72 hours.

Table 1.

Properties of the Four Microbial Air Samplers

	M Air T (Millipore)	STA-203 (New Brunswick Scientific)	RCS High Flow (Biotest)	RCS PLUS (Biotest)
Particle capture mechanism	Impaction	Impaction	Centrifugal impaction	Centrifugal impaction
Sampling volume (maximum)	1,000 L	3,000 L	1,000 L	1,999 L
Time to sample 1,000 L (1 m^3)	6.5 min (140 L/min 1st 500 L, 180 L/min 2nd 500 L)	20 min (50 L/min)	10 min (100 L/min)	20 min (50 L/min)
Water loss after sampling 1 m^3*	4.2%	4.3%	10%	13%
Particle diameter cutoff size (d_{50})	3.5 µm	0.5 µm	2-5 µm	2-5 µm
Aspiration mechanism	Impeller below agar cassette	Vacuum required	Impeller perpendicular to agar strip	Impeller perpendicular to agar strip
Agar volume	34 mL	65 mL	8 mL	8 mL

*In an unclassified environment with 53% relative humidity. Sample size was 120 per tester.

Results

Overall results for the unclassified room studies showed a significant difference among samplers and a significant difference among test positions.*

The overall analysis for the unclassified room suggested a significant difference in recovery for certain pairs of samplers. A pairwise analysis performed on the 48-hour and 72-hour plate counts demonstrated no significant difference between the M Air T and the STA samplers and no significant difference between the RCS PLUS and RCS High Flow samplers. There was a significant difference in recovery between the grouped M Air T/STA and the grouped RCS PLUS/RCS High Flow data (Figure 3).

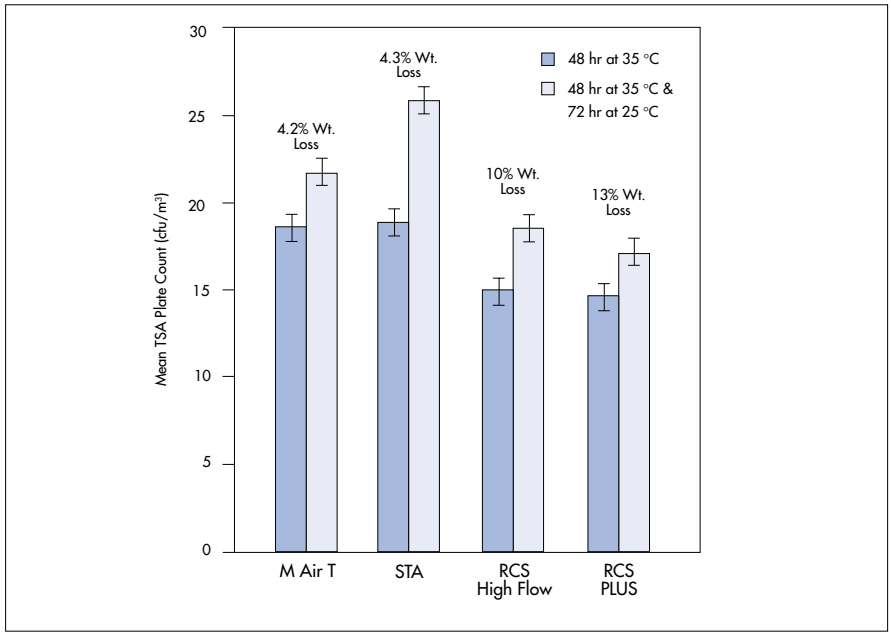
Discussion

A significant increase in plate counts was observed during the two-stage incubation of 48 hours at 35 °C followed by 72 hours at 25 °C for the unclassified area.

The percent weight loss of the agar in the unclassified room appeared to be related to recovery. M Air T and STA had lower percent water loss and higher microbial recovery as compared to RCS PLUS and RCS High Flow. The mean final incubation plate count ranged from 18 to 26 cfu.

Figure 3.

Mean Recovery and Standard Error for Four Different Microbial Air Samplers Operated Simultaneously in an Unclassified Test Room.



Conditions: 53% relative humidity; 48 hr incubation at 35 °C versus 48 hr incubation at 35 °C followed by 72 hr incubation at 25 °C.

Conclusions

- Test position was found to have a significant effect upon microbial recovery. By using a proper test design with switching of air samplers among positions, this bias was eliminated from the test results.
- When higher counts are encountered, a statistically significant difference in sampler recovery is observed. In this environment, M Air T is equivalent to STA and more sensitive than RCS PLUS and RCS High Flow.
- Increased sensitivity is important, particularly if the sampler is used in a variety of testing environments or if a test area encounters spikes in microbial counts.

Authors

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For Additional Information

For a complete copy of the presentation, request Millipore document TB002EN00.

* Plate counts were transformed to the square root of the count and analyzed using a general linear ANOVA for a DOE design for all air samplers (a 0.05). All data were analyzed using Minitab release 12.2 (Minitab, Inc., State College, Pennsylvania).

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