Efficiency of the M-Vac™ Spray-Extraction Surface Sampler for the Recovery of Viruses and Toxins

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Highly pathogenic bacteria, viruses, fungi and toxins are regarded as potential biowarfare (BW) agents. For rapid detection methods and verification, it is of great importance to provide sufficient amounts of antigen and nucleic acids. So, one of the main tasks is the efficient sampling of BW agents from different kinds of surfaces, even porous concrete pavements, carpets, wooden surfaces or plants where using swabs can be extremely ineffective.

We evaluated and improved the recovery of a prototype of the new spray-extraction surface sampling instrument "M-Vac™" from Microbial-Vac Systems Inc. It consists of a wet–vacuum device and a hand-held spray-extraction sampling head. The instrument will allow field teams to sample much larger surface areas with high collection efficiency.

Microbial-Vac Systems® Spray-Extraction Surface Sampling Technology

Figure 1: LRTC with filter assembly and small sampling head; insert: large sampling head; both prototypes

The Microbial-Vac System™ is designed to sample low levels of surface microbial pathogens or other particles from diverse surface types, with considerably higher efficiency than is possible with typical cotton or sponge swabs.

The vacuum-collected, liquid-pathogen suspension can then be subsampled from the M-Vac's Liquid Retention and Transport Chamber™ (LRTC) or concentrated by filtration onto the removable final filter provided in the unit's Final Filter Assembly (FFA; see fig. 1).

In the center of M-Vac's sampling head (see fig. 1) a nozzle is situated, from where pressurized sampling liquid is sprayed to the surface of interest while the liquid containing the pathogenic agents are sucked by vacuum into the sample bottle. If wanted, the FFA can be fitted with a membrane filter to concentrate larger particles like bacteria. The remaining liquid can be analysed for viruses and toxins. The vacuum for sampling and pressure for the liquid is provided by the central device which contains all technical equipment.

The final instrument (fig. 2) will be portable, the assembly of LRTC and sampling head will be provided sterile and for single use.

Figure 2: M-Vac™, new commercial version, with single use sampling head and liquid delivery by separarte pump system

Methods

Efficiency evaluation of M-Vac® sampling was performed on surfaces of planed lime wood, concrete sidewalk pavement, synthetic floor carpet and lime or acorn leaves in comparison to stainless steel surfaces and swabs (cotton and foam) as standards, using M-Vac's Surface Rinse Solution (SRS) and minor modifi-cations thereof for elution.

Coffeine and bovine serum albumine (BSA) were used as toxin simulants, model viruses for the Alphavirus group were Pixuna (PIXV), Sindbis (SINV) and Semliki Forest Virus (SFV).

The agents were spotted and dried to the different surfaces within an area of 10 x 10 cm and extracted with M-Vac's small sampling head for 30 sec, resulting in about 30 mL of sample. The total amount of viral antigen dispensed was in the range 10^6- 10^9 $TCID_{50}$ per experiment.

As the results from this kind of experiments normally have distinct variations, the data aquired until now in most cases are preliminary. Statistical evaluation still has to be done.

Results

Toxin simulants:

As expected, recovery of model protein and toxin simulants from stainless steel surfaces (results not shown) was highly effective in the range of 85-100%, as like as with cotton swabs . Recovery of PIXV varied between 8 to 61 % depending on spotted concentrations of $3x10^7$- $5x10^9$ $TCID_{50}$ compared to swabs (2- 27%).

From planed wooden and concrete surfaces (fig. 4 and 5), coffeine was recovered at about 22% and 11% respectively, recovery of BSA was about 25-26% for both. There was no recovery by swab sampling of protein from concrete.

BW viral agent simulants:

Model Alphavirus recovery for PIXV, SINV and SFV from concrete and wood as expected was much lower in the range of 0.1% to 0.5% (fig. 3). However, results of swab sampling never exceeded 0.004% from concrete and 0.1% from wood. Unexpectedly, even from carpet virus recovery was possible at about 0.2%.

Regarding that the agents were not concentrated from the sampling liquid, these recoveries are comparably sufficient for classical viral diagnostic methods. In the case of suspected BW agent incidence, sampling should be done from much larger areas, followed by effective concentration to reduce the amount of liquid to be analysed.

In parallel, our results show the need to adapt the formulation of the sampling solutions to agent and surface to be sampled. This will be allowed by the new design of the M-Vac™.

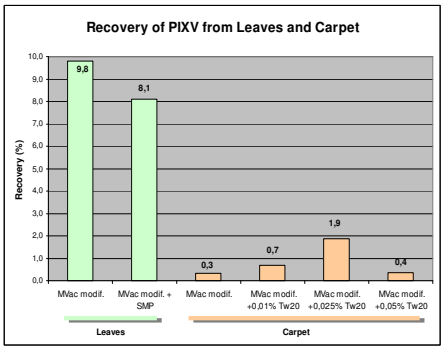

Figure 3: Recovery of PIXV from leaves and carpet including modifications of the SRS; addition of skim milk powder (SMP) did not enhance efficiency at leaves, whereas addition of up to 0,025% Tween 20 for carpet sampling significantly increased the recovery. -- MVac modif.: sampling liquid pressurized by separate pump.

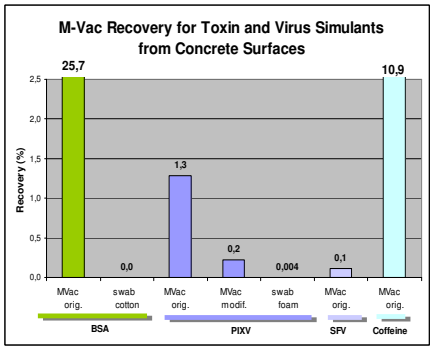

Figure 4: Recovery of BSA, PIXV, SFV and coffeine from concrete pavement; swab recovery partly was at undetectable level, MVac clearly was able to recover suffient virus for detection; -- MVac modif.: sampling liquid pressurized by separate pump; MVac orig.: original configuration

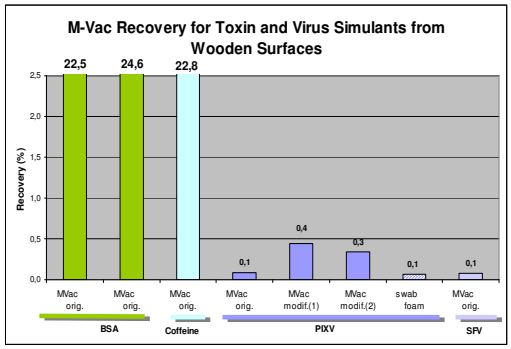

Figure 5: Recovery of BSA, PIXV, SFV and coffeine from wooden surfaces; swab recovery level was noticably better than from concrete, modification of liquid delivery system clearly enhanced virus recovery; -- MVac modif. (1 and 2): sampling liquid delivery modified with two different separate pumps; MVac orig.: original configuration

References:

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