



Wind tunnel comparison of the collection efficiency of three Hirst-type volumetric sampler drum coatings

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Abstract

A large number of sites worldwide measure airborne pollen and fungal spore concentrations using a Hirst-type volumetric impaction sampler. In Europe a number of adhesive drum coatings are routinely used. The drum coating routinely used in the UK, V/P, consisting of 90% petroleum Jelly (Vaseline)/10% paraffin wax, has not previously been compared with other coatings, for fungal spores or pollens. The collection efficiency of different coatings was compared in a wind tunnel, at IACR-Rothamsted. Spores of different species were released and trapped in identical miniature suction traps which reproduce the aerodynamic features of a full size Hirst-type spore trap. The trapping surfaces were coated in one of three commonly used drum coatings: (1) V/P; (2) Silicone Fluid; (3) Glycerol Jelly. These are all used in Europe and both V/P and Glycerol Jelly are used the UK.

Four spore types, *Lycopodium clavatum* (moss); *Alternaria alternata*; *Botrytis cinerea*; and *Calvatia excipuliformis*, which represent the size range of spores most frequently found in the air, were used. With the exception of *B. cinerea*, the numbers of spores collected on Glycerol Jelly were significantly smaller than on the other two coatings. For all spore types, the numbers caught on the V/P and Silicone Fluid were not significantly different.

1. Introduction

A large number of sites worldwide measure airborne pollen and fungal spore concentrations using a Hirst-type volumetric spore trap, such as the Burkard sampler. In Europe a number of adhesive drum coatings are routinely used. Some variations in collection efficiency, related to adhesive coating and temperature, have been demonstrated (Käpylä, 1989). In climates where the temperature regularly exceeds 30 °C, the collection efficiency of Vaseline is reduced so that, for regions where temperatures above 30 °C are regularly experienced. Silicone Fluid appears to be the most effective drum coating for pollen grains (Gálan and Dominguez-Vilches, 1997). A medium that remains stable at high temperatures is not essential for cooler areas of Europe. Little is known of the variability in media collection efficiency for fungal spores. Although work done by Comtois and Mandrioli (1997)

examined differences in trapping efficiency for pollen grains and for two fungal spore types: *Alternaria* and *Drechslera*, this study did not include the Vaseline/paraffin wax mix used at all but one of the National Pollen Network sites. The drum coating routinely used in the UK, V/P, consisting of 90% petroleum Jelly (Vaseline)/10% paraffin wax by volume (British Aerobiology Federation, 1995), has not previously been compared with other coatings.

2. Methods and materials

The wind tunnel at the Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, previously described by Fitt et al. (1986) was used to assess drum coating adhesive efficiency. Three adhesives were selected: V/P (90% petroleum Jelly (Vaseline) and 10% Paraffin wax (congealing point

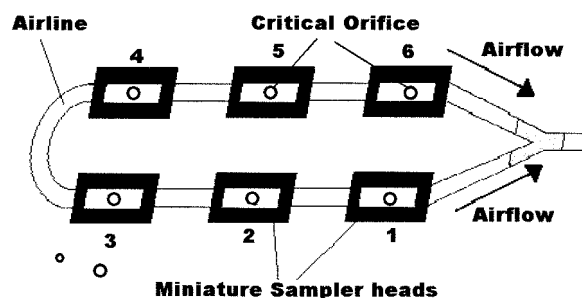


Figure 1. Position and connection of the six miniature sampler heads and the airflow through the system. Each miniature sampler head was connected to the air supply via a critical orifice so that the airflow was equal to that of a standard Hirst-type sampler.

65–71 °C) by volume dissolved in hexane); Silicone Fluid dissolved in carbon tetrachloride (Galán and Dominguez-Vilches, 1997); and commercially prepared Glycerol Jelly (18.8% gelatine, 50% glycerol, 1% phenol made up to 100% with water). All three drum coat adhesives are used in Europe and two: V/P and Glycerol Jelly are used within the UK. For each experiment, sampling within the wind tunnel was for a ten-minute period.

Six miniature sampling heads, which reproduce the orifice and airflow characteristics of a standard Hirst-type volumetric sampler, were used. The miniature sampler heads were supported by a framework and connected to an air supply via a critical orifice to regulate airflow at 10 l/minute (Figure 1). Each orifice was 2 mm × 14 mm, behind which was a plastic insert with a flat surface 4 mm × 16 mm at right angles to the orifice. The collecting surface on each insert was covered with Sellotape, cut to size and then coated with the appropriate adhesive coating. The actual flow rate for each miniature sampler was recorded so that the conversion factor calculations could be adjusted for each head. The flow rates were monitored regularly during the course of the experiments.

Four spore types were used to represent the size range of spores most frequently found in the air. Dry commercially purchased *Lycopodium clavatum* (moss) spores were used for to simulate larger spore types such as rust spores. Dry *Calvatia excipuliformis* (puffball) spores were extracted from fruiting bodies. *Botrytis cinerea* and *Alternaria alternata*, cultures were grown on malt agar impregnated wicks. Dry spores were discharged using a boiling tube diffuser, (McCartney and Aylor, 1987), supported by a framework. For *B. cinerea* and *A. alternata* the malt agar impregnated wicks supporting the cultures

were suspended from the frame, so that the spores were removed from the sporulating cultures by the airflow passing the frame. Separate experiments were conducted to assess the impaction of each spore type.

The wind speed within the wind tunnel was set to 2.5 m/sec and recorded. For each experiment two heads were used for each of the three drum coatings. During the experiments windspeed varied from 2.19 to 2.89 m/sec with an average of 2.59 m/sec. The temperature ranged from 18.34 °C to 19.39 °C with an average of 19.05 °C. Relative humidity was not controlled, but was recorded and varied from 48.03% to 60.30%, averaging 53.58% during the experiments. The positions of each drum coat adhesive within the framework were recorded and the experiment was run three times so that each drum-coating adhesive was tested on each of the six miniature heads to account for any nonhomogeneity in spore distribution across the wind tunnel. During the experiment using cultured *A. alternata* samples, the framework was agitated to assist in spore dispersal.

After exposure the adhesive coated Sellotape was removed from the inserts and mounted on glass microscope slides using a Glycerol Jelly mountant under glass coverslips. Each sample was examined using four transverse traverses, each 250 µm wide from within the central 8mm area of the tape. The results were converted into spores/m³ air. The results were analysed statistically using a Kruskal-Wallis One-Way non-parametric ANOVA; together with Multiple Comparisons with Rank Sums and Means (Tukey-HSD) (Table 1). The Tukey-HSD test assigns superscripts which show homologous sub-sets based upon significantly different drum coating capture rate means. Non-parametric statistical tests were selected because the sample size was small. although non-parametric tests are slightly less powerful it is appropriate to use them in this case as they are reliable where distribution is not normal due to the sample size.

3. Results

Alternaria alternata

Glycerol Jelly trapped significantly fewer *A. alternata* spores than the other two coatings (99.9% level of significance), (Table 1). Glycerol Jelly trapped 70% of the number of spores trapped by Silicone Fluid and only 64% of the number of spores trapped by V/P, (Figure 2). Although Silicone Fluid trapped less spores

Table 1. Statistical results using a Kruskal-Wallis one-way non-parametric ANOVA (K); together with multiple comparisons with rank sums and means: Tukey-HSD (honestly significant difference)

Spore type	Kruskal-Wallis ANOVA 99.9% prob. $K_{critical} = 9.21$ 99.5% prob. $K_{critical} = 5.99$	Tukey-HSD showing homologous sub-sets		
<i>A.alternata</i>	$K = 20.335$ (99.9%)	V/P (a)	Silicone Fluid (a)	Glycerol Jelly (b)
<i>L.clavatum</i>	$K = 10.327$ (99.9%)	V/P (a)	Silicone Fluid (a)	Glycerol Jelly (b)
<i>C.excipuliformis</i>	$K = 05.997$ (99.5%)	V/P (a)	Silicone Fluid (ab)	Glycerol Jelly (b)
<i>B.cinerea</i>	$K = 1.997$ (not significant)	V/P (a)	Silicone Fluid (a)	Glycerol Jelly (a)

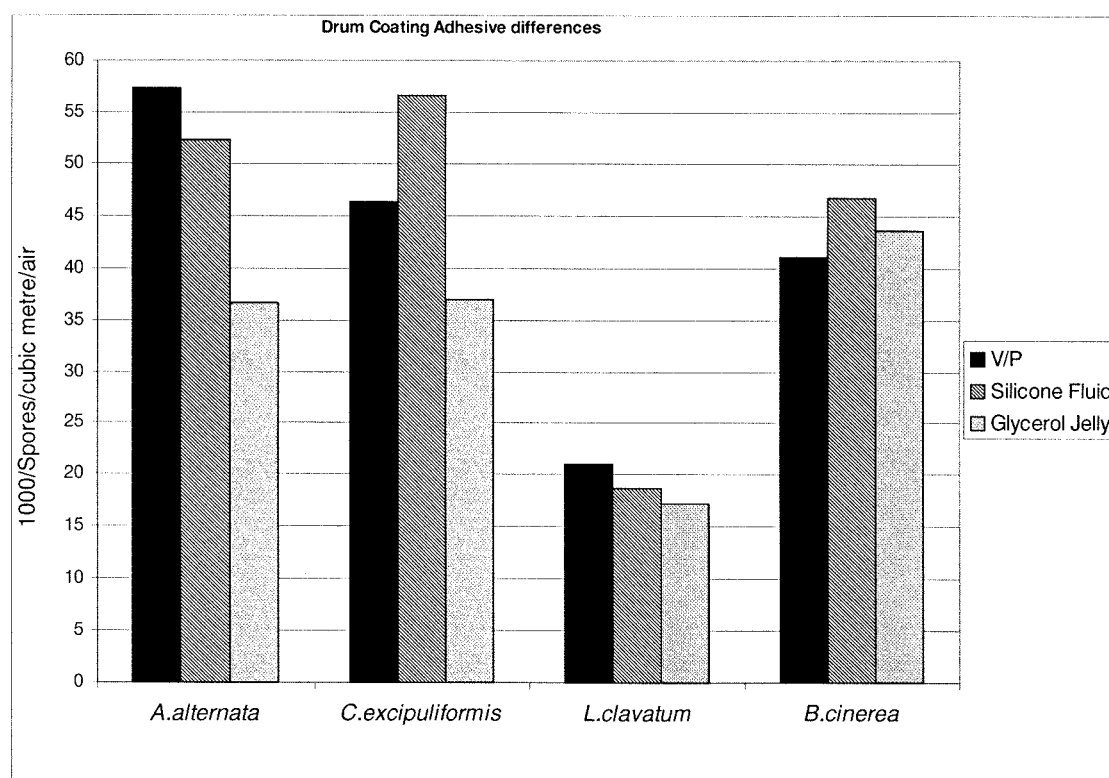


Figure 2. Differences in the numbers of spores trapped on each of the three drum coating adhesives.

than V/P (91%) this variation was not significant and both were assigned to the same sub-set (Tukey-HSD), (Table 1).

Calvatia excipuliformis

Glycerol Jelly trapped significantly fewer *C. excipuliformis* spores than either V/P or Silicone Fluid coatings, (99.9% level of significance), (Table 1). Glycerol Jelly captured 65% that of Silicone Fluid and 80% of the number trapped by V/P, (Figure 2). How-

ever, no significant differences were found between the numbers of spores trapped by V/P and Silicone Fluid and both were assigned to the same homologous sub-set (Tukey-HSD). Unlike *A.alternata* Silicone Fluid trapped more *C.excipuliformis* spores (122%) than V/P.

Lycopodium clavatum

V/P trapped more *L.clavatum* spores than either of the other two drum coat adhesives, (Figure 2). How-

ever, the only statistically significant difference was found between V/P and Glycerol Jelly, where Glycerol Jelly trapped only 82% of the number of spores trapped by V/P coatings (99.5% level of significance). Although Glycerol Jelly trapped fewer spores than Silicone Fluid this difference was not significant and both were assigned to the same sub-set (Tukey-HSD) (Table 1).

Botrytis cinerea

The smallest range of variation between the numbers of spores caught was for *B.cinerea* spores, (Figure 2). Although there was some variation in collection efficiency between the three drum coat adhesives this was not significant, (Table 1). Silicone Fluid trapped the most *B.cinerea* spores while V/P trapped the least.

4. Discussion

The results demonstrated some significant differences between the collection efficiency of the three drum coating adhesives. With the exception of *B. cinerea* Glycerol Jelly trapped significantly fewer spores than the other two drum coat adhesives. This confirms the non-significant differences reported by Comtois and Mandrioli (1997) where glycerine/gelatine coating produced the lowest overall pollen and spore collection efficiency when compared to Silicone Fluid and pure Vaseline. The wind tunnel results generally concur with Comtois and Mandrioli (1997) that the largest inter-media differences were found between Glycerol Jelly and V/P (this study) and pure Vaseline (Comtois and Mandrioli, 1997).

The presence of significant variation between some drum coating adhesives indicates that where possible standardised drum coat adhesives should be used. However, the variation between V/P and Silicone Fluid was non-significant, in this study and in the ones conducted by K  p  l   (1989), Comtois and Mandrioli (1997) and Gal  n and Dom  nguez-Vilches (1997) – under 30   C. Therefore the data collected using these two coatings is comparable for sites within the UK and Northern Europe.

5. Conclusions

For temperate regions, for instance the UK, where temperatures above 30   C are rarely recorded V/P or Silicone Fluid can be used. The results of this and other studies confirm that Glycerol Jelly, despite its good optical qualities should not be used to determine airborne spore concentrations if this data is to be compared with other sampling sites where V/P or Silicone Fluid is used. Glycerol Jelly tends to underestimate the numbers of spores present.

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