

INNOVALTECH INC.

**RESEARCH PROTOCOL
HAND DRYERS**

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**Presented to
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Research protocol

Hand dryer project

1.0 OBJECTIVES

To compare the microbiological quality of the air discharged from hand dryers manufactured by **COMAC CORPORATION INC.** as compared with that of paper hand towels.

2.0 INTRODUCTION

There are usually two (2) options for drying your hands in a public washroom, i.e. paper towels or hand dryers. Can this process of drying our hands potentially lead to recontamination? If so, is using a hand dryer more hygienic than drying our hands with paper towels?

Given that hand dryers use the air from the room in which they are located, i.e. public washrooms, is the air discharged from these devices contaminated? Is the discharged air, which is heated by the electrical elements in the dryer, of better quality than the room air, from a microbiological perspective? This study will attempt to answer these questions.

INNOVALTECH INC. was mandated to conduct a comparative microbiological study on the use of a hand dryer versus using paper hand towels. The aim of this study is to determine whether the air discharged from hand dryers is microbiologically contaminated and to compare this result with that for paper hand towels.

To accurately represent the real situation of a possible microbiological contamination, the hand dryers tested are those currently installed and used at various places of business of our clients, i.e. in public washrooms. The sites were chosen so as to represent a range of environments:

- Restaurants;
- Department stores;
- Shopping centres.

Laboratoires d'analyses S.M. inc. was mandated by Innovaltech to do the sampling and microbiological analyses. The sampling took place on Thursday, February 21, 2008.

3.0 MATERIALS AND METHODS

3.1. HAND DRYERS TESTED

3.1.1. BRANDS AND MODELS

- a) Nova1 (7,500 RPM)
- b) Nova5 (153 CFM)
- c) Nova series 18626
- d) World Dryer, model A, 2111 series
- e) Ouellet

3.2. AIR SAMPLER

3.2.1. MAS-100 AIR SAMPLER

Mélanie Boucher, a technician from Laboratoires d'analyses S.M. inc., used the MAS-100 air sampler to test the air. This method enables the counting of the yeasts and moulds, and aerobic and facultative anaerobic heterotrophic bacteria (AAHB) present in the air.

The MAS-100 is an effective device, based on the principles described by Andersen, which aspirates air through a perforated plate. The resulting particle-charged air stream is directed onto the agar surface of a standard Petri dish. At the end of a collection cycle, the Petri dish is incubated and the colonies are counted. The MAS-100 operates with a high-performance suction device that continuously monitors the airflow. It measures the incoming airflow and regulates the aspirated air to a constant flow of 100 L/min. Laboratoires d'analyses S.M. inc. provided the protocol used for the air sampler.¹

¹ Échantillonnage et dénombrement des levures & moisissures et **BHAA** dans l'air avec le MAS-100 [Sampling and counting of yeasts and moulds, and AAHB in the air using the MAS-100], Laboratoires d'analyses S.M. inc., ILME-39, version no. 1.

3.3. SAMPLING

The following were sampled at each site:

- 1) The air discharged from the hand dryer
- 2) The air in the room where the hand dryer is located (the control)
- 3) Paper hand towels

All of the hand dryers tested were located in public washrooms. Each site was identified as either a men's washroom or a women's washroom.

3.3.1. MICROBIOLOGICAL PARAMETERS ANALYZED

- Aerobic mesophilic bacteria (AMB) count;
- Aerobic and facultative anaerobic heterotrophic bacteria (AAHB) count;
- Yeast and mould (Y&M) count;
- *Escherichia coli* [*E. coli*] and total coliform count (EC/CC).

All microbiological analysis methods used for this study are officially approved methods of the Health Products and Food Branch.²

3.3.2. COLLECTING THE AIR

We estimated that each person uses the hand dryer for about 30 seconds. According to the preliminary test using the sampler, the volume of air discharged from the hand dryer in a 30-second period is 50 L. Therefore all microbiological counts are based on this volume.

The air sampler was placed over and beside the hand dryer outlet in order to aspirate the air (rather than the air being forced into it). Therefore, regardless of the hand dryer model and the number of CFM, the volume of air sampled was consistently 50 L.

² Health Products and Food Branch, Compendium of Analytical Methods, Volumes 1-5.

3.3.3. ROOM AIR

The sampling of the room air was done using the air sampler for the same amount of time as for the hand dryers, i.e. 30 seconds for a volume of 50 L. This data will be used as a control for the air discharged from the hand dryer.

Additional sampling of the room air over a 1-minute period (i.e. 100 L) was done (a series of 2 tests) for the purposes of comparing it to the 50-litre samples.

3.3.4. PAPER HAND TOWEL

It was determined that, on average, people use two (2) paper towels to dry their hands. The weight of 2 paper towels varies according to the type of paper, i.e. between 3 and 5 g. To standardize the weight, 4 g of paper were used for the microbiological analyses. Paper hand towels were sampled at each site using an aseptic technique.

At the laboratory, the paper towels from each site were weighed (4 g), and a suitable diluent was added to obtain a 10⁻¹ dilution. This dilution was then homogenized in a stomacher and analyzed according to the microbiological parameters defined in section 3.3.1. The test results are based on a 4-g sample.

4.0 RESULTS SUMMARY

		Micro	Dryer air	Room air	Comparison		Dryer model	
					Reduction, dryer vs. room	Paper towel		Reduction, dryer vs. paper
1	Tim Hortons, 155 Taschereau	Yeast	0	2	100%	-	-	Nova5
	Women's washroom	Mould	0	1	100%	-	-	
		AMB	72	81	11%	-	-	
		EC/TC	0	0	0%	-	-	
2	Rona, 9105 Taschereau							
		Yeast				0		
	Women's washroom	Mould				0		
		AMB				45	-60%	
		EC/TC				0		
3	Pasta Tutti Giorni, 7681 Taschereau							
		Yeast	0	7	100%	0		Nova 18626
	Men's washroom	Mould	0	0	0%	0		
		AMB	6	64	91%	0	-6%	
		EC/TC	0	0	0%	0		
4	Wal-Mart, Quartier Dix-30							
		Yeast	0	0	0%	0		World Dryer
	Women's washroom	Mould	0	0	0%	0		

		AMB	7	5	-40%	75	91%	
		EC/TC	0	0	0%	0		
4	Wal-Mart, Quartier Dix-30							
		Yeasts	0	0	0%			World Dryer
	Men's washroom	Mould	0	0	0%	0		
		AMB	6	8	25%	20	70%	
		EC/TC	0	0	0%	0		
5	Tim Hortons, 2141 Lapinière							
		Yeasts	0	0	0%	-	-	Nova1
	Men's washroom	Mould	1	0	0%	-	-	
		AMB	5	1	-400%	-	-	
		EC/TC	0	0	0%	-	-	
6	Food court, Champlain Mall							
		Yeast	2	3	33%	0		Nova5
	Women's washroom	Mould	0	0	0%	0		
		AMB	12	11	-9%	0	-12%	
		EC/TC	0	0	0%	0		
6	Food court, Champlain Mall							
		Yeast	11	31	65%	0		Nova5
	Men's washroom	Mould	1	0	0%	0		
		AMB	9	36	75%	0	-9%	
		EC/TC	0	0	0%	0		
8	IKEA							
		Yeast	0	0	0%	0		Nova5
	Women's washroom	Mould	0	0	0%	0		
		AMB	6	16	63%	10	40%	
		EC/TC	0	0	0%	0		
8	IKEA							
		Yeast	0	1	100%	0		Nova5
	Men's washroom	Mould	0	0	0%	0		
		AMB	2	9	78%	5	60%	
		EC/TC	0	0	0%	0		
7	Rona, Boucherville							
		Yeast	0	0	0%	0		Ouellet
	Men's washroom	Mould	10	38	74%	0		
		AMB	46	5	-820%	920	95%	
		EC/TC	0	0	0%	0		

	Average AMB		20.8*			215.0		
	Average yeast reduction			40%				
	Average mould reduction			17%				
	Average AMB reduction			37%			30%	
	% more AMB on paper vs. dryer air					90%		

* Rona Boucherville was excluded from the average for hand dryers due to the tremendous difficulty turning on the dryer.

5.0 DISCUSSION

The sites chosen for this study represent different real-life environments and living conditions: restaurants, department stores and shopping centres. Since the samples of air discharged from the hand dryers were taken in the washrooms (where the dryers are located) of these establishments, so were the samples of room air and paper towel. Each site was identified as being a men's washroom or a women's washroom, and the respective brands and models of hand dryer were indicated.

Given the short time in which to collect the samples, i.e. a single day, the sites chosen were all located within a 25-km radius on the South Shore of Montreal (La Prairie, Brossard and Boucherville). The sampling at the sports arenas did not take place due to lack of time. Eight (8) sites were selected.

Some of the sites, such as *Tim Hortons*, *Pasta Tutti Giorni*, *Champlain Mall*, *IKEA* and *Rona Boucherville* have all been in operation for several years, whereas others were built only a few months ago, such as *Wal-Mart* and *Rona Quartier Dix-30*. One of our initial hypotheses was that the older sites would be more contaminated than the newer sites. This hypothesis proved to be true in one (1) case.

We also wanted to determine whether there was a difference between the different hand dryer models.

Our initial results analysis revealed that the room air contained mostly yeasts and AAHB. One site (*Rona Boucherville*) had a higher mould count (38 cfu³/50 L) than the others. In general, the level of contamination of the room air is low, considering the samples were taken from washrooms. See the certificates of analysis in Appendices 1 and 2.

No *E. coli* or total coliforms (EC/CC) were detected in any of the samples of room air or air discharged from the hand dryer. These results were expected; however, we did the analysis for the purpose of comparing it to that of the paper towel, which was more likely to be contaminated). No paper towel sample in the study tested positive for *E. coli* & total coliforms.

Test results from two (2) additional room air samples taken over a 1-minute period (i.e. 100 L) confirmed that the results obtained for the 50-L samples were acceptable, since there was little difference between the results. The sites sampled were the women's washroom (7 cfu/50 L and 5 cfu/100 L of AAHB) and

³ cfu: colony-forming unit, used to express results of microbiological analyses

the men's washroom (5 cfu/50 L and 3 cfu/100 L of AAHB) of *Wal-Mart Quartier Dix-30*.

Six out of eight paper towel samples were moderately to highly contaminated with aerobic mesophilic bacteria, including recently built sites that were theoretically less contaminated, i.e. *Rona Dix-30* (45 cfu/4 g aerobic mesophilic bacteria) and *Wal-Mart Dix-30* (75 and 20 cfu/4 g aerobic mesophilic bacteria).

The worse result for hand towels was that of *Rona Boucherville* (920 cfu/4 g aerobic mesophilic bacteria), indicating that this paper towel was a strong contaminant and could be an important vector for transferring bacteria onto substrates, e.g. food. In this particular case, the hand dryers reduced contaminants (aerobic mesophilic bacteria) by 95% as compared with paper. This reduction may be even greater, since we had many problems collecting the air sample from the hand dryer (*Ouellet* brand); excessive handling involved in frequently turning the unit on and off to obtain the necessary 50 L of air may have resulted in the contamination of the unit.

At *Rona Boucherville*, a reduction of 74% in yeasts and moulds was observed between the room air and the air discharged from the hand dryer. This site had the highest mould count for room air (38 cfu/50 L yeasts and moulds).

There was a reduction in aerobic mesophilic bacteria and in yeasts and moulds in the air discharged from the dryer as compared with the room air, e.g. *Tim Hortons* (155 Taschereau) 11%, *Pasta Tutti Giorni* 91%, *Wal-Mart (Dix-30)* 25%, *Champlain Mall* 75%, and *IKEA* 63% and 78%.

With respect to the reduction in yeasts, the results are as follows: *Tim Hortons* (155 Taschereau) 100%, *Pasta Tutti Giorni* 100%, *Champlain Mall* 33% and 65%, and *IKEA* 100%. A reduction in moulds was observed at only 2 sites, since no moulds had been detected in the room air at the other sites: *Tim Hortons* (155 Taschereau) 100% and *Rona (Boucherville)* 74%.

There was a slight negative reduction (i.e. an increase) in aerobic mesophilic bacteria observed at 3 sites: *Wal-Mart (Dix-30)* from 5 cfu/50 L in the room air to 7cfu/50 L in the air discharged from the dryer, and *Tim Hortons* (2141 Lapinière) from 1 cfu/50 L in the room air to 5 cfu/50 L in the air discharged from the dryer. The result from the third site, *Rona (Boucherville)*, was excluded given the difficulties encountered during the sampling of the hand dryer (possible contamination by the person conducting the test): from 5 cfu/50 L in the room air to 46 cfu/50 L in the air discharged from the dryer.

In summary, a 37% reduction in aerobic mesophilic bacteria, a 40% reduction in yeasts and a 17% reduction in moulds were observed in the air discharged from the dryer as compared to the room air. Based on these results, the air discharged

from the hand dryers is less contaminating than the room air, i.e. the air entering the device.

There was a 30% reduction in aerobic mesophilic bacteria observed for the hand dryer as compared to the paper towel. There were 90% more aerobic mesophilic bacteria in the paper than in the hand dryer.

Note that similar levels of contamination were found in the women's washrooms as compared with the men's washrooms; no clear differences were observed in the results for these sites.

Moreover, the combined results show no significant difference between the various models of hand dryer (*Nova1*, *Nova5*, *World Dryer* and *Ouellet*); we believe that the differences observed between the models are attributable mainly to how well each unit is maintained. Proper maintenance ensures that the interior of the device and the elements found therein are clean and free of contaminating dust and, consequently, that cleaner air is discharged from the device. Was the *Ouellet* unit adequately maintained?

This raises another issue. The overall appearance of the *Rona Boucherville* site, in relation to its respective microbiological results, leads us to suspect that maintenance—including that of the hand dryer and the paper towel dispenser—is inadequate. Even if we assume that no contamination took place during the sampling, the results for aerobic mesophilic bacteria observed for the hand dryer (46 cfu/50 L) are nevertheless far superior to those for the hand towels (920 cfu/4 g)! At this level of contamination, the paper towels are both a reservoir and a vector for microorganisms. We had not anticipated this result.

The heated air discharged from the hand dryer is a natural barrier against microorganisms, i.e. it has a lethal effect that hand towels simply do not have.⁴ Even if not maintained, a hand dryer is still the best choice, by far. It would be interesting to conduct another study that includes a greater number of older sites where maintenance is more likely to be inadequate.

⁴ "Hand Dryer and Hygiene, A definitive statement on the bacteriological safety of warm air."

6.0 CONCLUSIONS

Based on the study results, our conclusions can be summarized as follows:

- The room air in the sampled sites contained mostly aerobic and facultative anaerobic heterotrophic bacteria, as well as yeasts and moulds, but in a lower concentration.
- The air discharged from the hand dryer contained fewer microorganisms than the room air.
- The paper towel was moderately-to-highly contaminated with aerobic mesophilic bacteria, and the air discharged from the hand dryers contained significantly fewer organisms.
- In some cases (3), the air discharged from the hand dryer was more contaminated than the room air, but the difference was minimal.
- There were no differences between the women's washrooms and the men's washrooms.
- With the exception of the *Ouellet* model, there was no difference observed between the various models.
- We concluded that the hand dryers require periodical maintenance to sustain their initial performance level, as do the paper towel dispensers.
- A paper towel dispenser that not maintained or is poorly maintained can be a source and a vector of significant bacterial contamination for the hands.

More tests are required to further this study and to confirm the effectiveness of dryers in other environments, such as the agri-food sector. These tests could be conducted on sites other than those included in this study, e.g. gymnasiums, municipal swimming pools or arenas. These sites could reproduce the humid air found in agri-food plants. The results of those tests would provide more information on the comparative reduction in bacteria between hand dryers and paper towels. In a humid environment, the concentration of yeasts and moulds should be higher than that observed in this study.

Moreover, this study took place during in winter. For the room air, the level of natural contamination with yeasts and moulds is normally lower at that time of year. It would be preferable to do further tests in summer, when yeasts and moulds are at their peak, and to confirm the reduction.

In conclusion, given the results of this study, it would be useful to test sites where the dryers have been in place for a long period of time (e.g. several years) and where equipment maintenance (hand dryer and paper dispenser) is inadequate, in order to confirm whether paper towels are a major source of contamination for the hands.

[signed]
Valérie Charest, B.Sc., Microbiologist

APPENDIX 1

Certificate of analysis: Paper towels

APPENDIX 2

Certificate of analysis: Air discharged from the hand dryer and room air