THE VALUE OF A DESICCANT IN THE CLEANING AND DISINFECTION OF SWINE HOUSING

Prepared for

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Executive Summary

This study looked at the use of a commercial desiccant (DryStart™) to determine if its use can aid in the cleaning and disinfection of commercial pig production surfaces. The product was applied after routine cleaning and cleanliness was determined by swabbing the surface and counting the number of bacterial colonies.

There were two trials performed, one where the desiccant was compared to the use of commercial disinfectants in a finishing barn. The second study looked at its use in a commercial farrowing room. There results were as follows:

Trial 1 Bacterial counts on finishing barn floors after treatment

Treatment	Average Bacterial count (colonies/10cm of floor)	Bacterial load reduction due to use of desiccant*
Disinfectant 1	92.25 [a]	
Disinfectant 2	56.25 [b]	
Desiccant*	22.18 [c]	-335%
Disinfectant 1and Desiccant*	14.27 [c]	-646%
Disinfectant 2 and Desiccant*	13.94 [c]	-403%

a is statistically different from b, and c
*Commercial Desiccant used was DryStart™

Trial 2 Bacterial counts (colonies/20cm swab) after treatment of farrowing room floors

Surface	Control	Desiccant*	Bacterial load reduction due to use of desiccant*
Plastic	110.7 [a]	32. 7 [b]	-306%
Steel	73.1 [a]	24.6 [b]	-297%

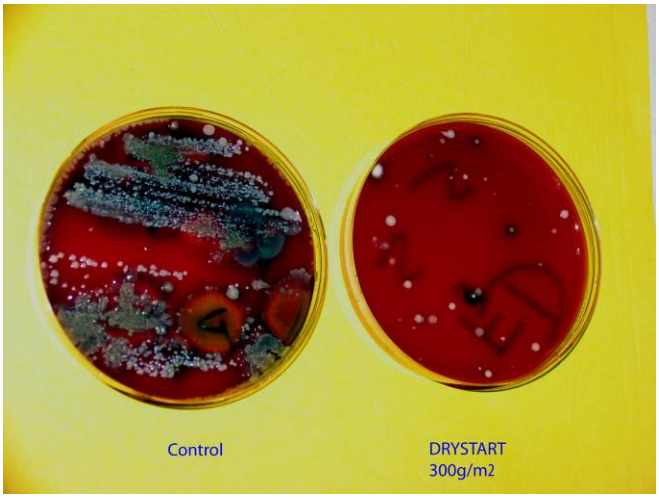
a is statistically different from b,
* Commercial Desiccant used was DyStart™

Conclusions to date

Whether it is through increased drying efficiency, or some other antibacterial effect, the use of a desiccant did reduce total bacterial load in finishing pens more effectively than common disinfectants.

The application of DryStart™ on top of conventionally washed and disinfected farrowing crate floors, on average, cut the bacterial load significantly. Treated pens had 3 times fewer bacteria than untreated pens.

The severity of many diseases is dependent on the initial dose animals are exposed to; it would be logical to expect that DryStart™ treated pens would have a lower incidence of disease.



Background

Pig production is continually evolving, to meet society's demands. Traditionally food was produced in mixed family farms where self-sufficient producers raised a variety of crops and livestock. To meet the need for increasing food supplies at the lowest price, farmers adapt by increasing production volume and specializing in fewer commodities. Increased livestock numbers and densities have increased the risk and prevalence of animal diseases. The use of antimicrobials to treat and prevent bacterial diseases became a routine farm practice, as has the design of animal flow to prevent the transmission of disease. A key prophylactic practice is the sanitation of rooms or buildings between batches of animals. Sanitation involves the high pressure cleaning of the livestock pens and an application of a disinfectant to kill remaining pathogens. Concern about antimicrobial resistance transferring from agricultural use to human populations is putting pressure on agriculture to rationalize the agricultural use of antibiotics. On farm sanitation practices will become increasingly important to modern efficient farming.

Cleaning and disinfection while critical to disease prevention has not been given as much focus and training as it could. Often choice and application of disinfectants on farm has been haphazard without consideration of effectiveness and applicator safety. Disinfectants are potent chemicals that can be significant hazards. For example one traditional choice has been a creosote-based disinfectant, which while killing microorganisms expose applicators to a persistent chemical that can bioaccumulate. Newer safer choices are available which range from to quaternary ammonium products, organic acids and hydrogen peroxide. These products all have different properties which need to be considered during their use.

In this study a comparison was made between a formaldehyde disinfectant, a hydrogen peroxide/organic acid combination) and a desiccant in a commercial setting. The desiccant has the advantage that it is simpler to apply, reduces water and chemical use, and from some initial data, reduces bacterial load (table 1 below). If it can be shown to be equal or superior to commercial disinfectants it will have significant value to commercial production.

Table 1
DryStart™ Pilot observations

Bacterial counts per 10 cm surface area sampled in 33 commercial finishing pens after cleaning and disinfection.

treatment	Mean
control	11
DryStart™	6.8125
Total	8.969697

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	144.532197	1	144.532197	1.96	0.1715
Within groups	2286.4375	31	73.7560484		
Total	2430.9697	32	75.967803		

Bartlett's test for equal variances: chi2(1) = 4.1963 Prob>chi2 = 0.041

Materials and Methods

Trial 1

- The pigs were housed in the ASRP research facility (Figure 2 below) on the Union Road, Prince Edward Island.

Treatment Allocation

Figure 1: Pig Production Innovation Group Swine Facility - Union Road PEI.

Calendar of Events

Date	Event
November 2007	Previous batch of pigs Sold
November 19 2007	Washed pens 1-40
November 20 2007	Applied disinfectant
November 21 2007	Applied DryStart™
November 23 2007	Swabbed clean pens
November 23 2007	New pigs arrived

Pens																				
	A	B	C	D	E	B	A	C	E	D	E	B	C	A	D	B	E	D	B	C
	E	D	C	B	A	D	E	C	A	B	D	A	C	B	E	C	A	D	E	A

North/East

Code	
A	A Profilm
B	B Hyperox
C	C Drystart™
D	D Profilm and DryStart™
E	E Hyperox and DryStart™

- The slatted portion of the barn has pens with fully slatted floors over a 4 foot deep liquid manure pit.
- The partially slatted end contains a 2-foot pit and 6 foot solid portion
- Each pen in both sections has a solid white PVC partition and a 2-space wet/dry feeder shared between two pens.

Research Activities

- Pens were allocated as the model above and washing commenced.
- Pens were left to dry before application of the disinfectant,
- Pens were disinfected at the recommended concentrations, 1:128 as per the pen outline above, and DryStart™ was applied at a rate of 150g/m^2
- Pens were swabbed in 5 locations in the pens using a 3M™ Quick Swab (http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/products/petrifilm-accessories/quick-swab), 2 floor samples as a control swab prior to disinfection, and 3 floor samples were taken after disinfectants were applied. The numbers of coliform bacteria were recorded using the 3M Petrifilm coliform Count plate. (http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/products/petrifilm-plates) and quantified using a 3M™ Petrifilm™ Plate Reader (http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/products/petrifilm-plate-reader)/
- 2 samples per pen were also taken 24 hours after disinfection using sterile swabs which sampled 10 cm of flooring and this was streaked on standard blood agar plates. The total number of colonies was recorded on each plate.
- A Random effects regression model that modeled the use of the treatment analyzed the outcome , with pens as a random effect


Drystart™ treated and untreated pens and swabbing of the floor

Results Trial 1

Blood Agar Swabs, measuring total bacterial load

```
Random-effects GLS regression                   Number of obs      =        79
Group variable (i): pen                         Number of groups   =        40

R-sq:  within  =      .                         Obs per group: min =         1
       between = 0.5378                                      avg =       2.0
       overall = 0.4274                                      max =         2

Random effects u_i ~ Gaussian                   Wald chi2(4)       =     40.65
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       total |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   _Itreat_2 |        -36   15.09473    -2.38   0.017    -65.58512   -6.414876
   _Itreat_3 |   -70.0625   15.09473    -4.64   0.000    -99.64762   -40.47738
   _Itreat_4 |  -78.10079   15.25568    -5.12   0.000    -108.0014   -48.20022
   _Itreat_5 |   -78.3125   15.09473    -5.19   0.000    -107.8976   -48.72738
       _cons |       92.25   10.67358     8.64   0.000     71.33016    113.1698
-------------+----------------------------------------------------------------
     sigma_u |  21.496004
     sigma_e |  29.805567
         rho |   .3421661   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Treatment effects

Treatment	Average Bacterial count colonies/10cm of floor	Standard Error
Profilm	92.25 [a]	10.06
Hyperox	56.25 [b]	10.06
Drystart™	22.18 [c]	10.06
Profilm and Drystart™	14.27 [c]	10.29
Hyperox and Drystart™	13.94 [c]	10.06

a is statistically different from b, and from c

The predominant bacterial strain was a coagulase negative *Staphylococcus* which is perhaps the most common environmental contaminant and an indicator of bacterial load.

Coliform analysis

```
Random-effects ML regression                    Number of obs      =       198
Group variable (i): pen                         Number of groups   =        40

Random effects u_i ~ Gaussian                   Obs per group: min =         3
                                                               avg =       5.0
                                                               max =         7

                                                LR chi2(5)         =      7.62
Log likelihood  = -737.42862                    Prob > chi2        =    0.1785
```

Coliform count	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
treatment_1	-1.001672	2.870718	-0.35	0.727	-6.628177	4.624832
treatment_3	1.985507	2.926325	0.68	0.497	-3.749984	7.720998
treatment_4	-1.097826	2.926325	-0.38	0.708	-6.833317	4.637665
treatment_5	-1.869565	2.957292	-0.63	0.527	-7.665751	3.92662
time	-3.075251	2.379538	-1.29	0.196	-7.739059	1.588557
_cons	5.423077	1.135523	4.78	0.000	3.197493	7.64866
/sigma_u	0	8.260205			.	.
/sigma_e	10.02867	.5039587			9.088017	11.06669
rho	0	.			.	.

```
Likelihood-ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

There was no difference in coliform counts between treatments and before and after disinfection. The underlying reason was that the initial counts were already quite low after the barn had been washed, and treatments could not lower the counts anymore than they already were. The time variable in the analysis above shows there was no statistical difference in coliform counts between before disinfection and after. The washing protocols using high pressure and soap removed most of the coliform bacteria. Coliform bacteria are gram negative bacterial and survive in manure and organic matter which normal washing removes.

Trial 2

Farrowing crates with both plastic and steel floors (steel under the sow, with plastic creep areas) were washed using a pressure washer and disinfected with Hyperox[1]. Once pens had dried overnight DryStart™ was applied to the farrowing crates, it was sprinkled until the surfaces were evenly covered. In a room of 12 crates 8 were given DryStart™, 4 were left as controls. A total of 3 rooms were treated, covering 24 farrowing crates with DryStart™. One (25 kg) bag of DryStart™ in total was used, using an approximate concentration of 1kg/crate, or 300g/per m^2 or 28 g/1 square foot. 48 hours after DryStart™ was applied, pens were tested for bacterial load using the following technique:

A 20 cm swab of the floor surface was taken using a sterile cotton swab. The swab was immediately streaked (10 cm) onto a blood agar plate. The plates were incubated in a standard bacterial incubator and were read after 36 hours. A total of 60 swabs were taken alternating between sampling a steel farrowing crate floor and a plastic floor. Two swabs per crate were taken in 3 separate rooms. The bacterial load was calculated by counting the total number of bacterial colonies on the 10 cm streak on the agar plate. The lower the count, the less contaminated the surface was.

The bacterial counts were analyzed using a mixed model random effects regression model where the application of DryStart™ was a variable, as was flooring type; the variation due to the rooms was a fixed effect and the crates were treated as random effect.

Results

The bacterial count data was not normally distributed and needed a transformation to approximate a normal distribution. The resulting regression model yielded the following result

```
Random-effects GLS regression                   Number of obs      =        59
Group variable (i): crate                       Number of groups   =        30
R-sq:  within  =      .                         Obs per group: min =         1
       between = 0.4879                                        avg =       2.0
       overall = 0.3906                                        max =         2
Random effects u_i ~ Gaussian                   Wald chi2(4)       =     23.45
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0001
------------------------------------------------------------------------------
      countn |      Coef.   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Iroom_2 |   .1713659   .3153225     0.54   0.587    -.4466548    .7893865
    _Iroom_3 |   .6314526   .3190086     1.98   0.048     .0062072    1.256698
     surface |  -.2803153   .2641384    -1.06   0.289     -.798017    .2373864
   treatment |  -1.141992   .2615157    -4.37   0.000    -1.654554    -.629431
       _cons |   4.275971   .4881396     8.76   0.000     3.319235    5.232707
-------------+----------------------------------------------------------------
     sigma_u |  .55710651
     sigma_e |  .60664853
         rho |  .45750618   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

The raw means were as follows:

```
  Summary of bacterial count/10cm of floor
  treatment |        Mean
------------+------------
    control |      89.8
   DryStart™ |      27.6
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[1] Paracetic acid and Hydrogen Peroxide based disinfectant

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Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	56704.4824	1	56704.4824	12.45	0.0008
Within groups	259708.907	57	4556.29662		
Total	316413.39	58	5455.4032		

oneway count surface, means

The flooring had a slight trend to ward the steel having a lower contamination rate, but it was not significant

Summary of bacterial count/10cm of floor

surface	Mean
plastic	71.7
steel	45.4

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	9854.0315	1	9854.0315	1.83	0.1812
Within groups	306559.358	57	5378.23436		
Total	316413.39	58	5455.40327		

There was some variation between rooms, with room three having more contamination than the others. However that difference was only found in the crates without DryStart™

Summary of bacterial counts without DryStart™ application

Summary of bacterial counts

room	Mean
1	61.1
2	65.2
3	166.14286
Total	89.851852

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	55086.0503	2	27543.0251	3.44	0.0486
Within groups	192157.357	24	8006.55655		
Total	247243.407	26	9509.36182		

Summary of bacterial counts with DryStart™ application

room	Mean
1	23.4
2	29.1
3	29.9

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	263.283333	2	131.641667	0.31	0.7338
Within groups	12202.2167	29	420.766092		
Total	12465.5	31	402.112903		

There was significant variation in bacterial counts between individual crates, but only in untreated crates. Crates that were treated with DryStart™ had no significant variation between crates

Summary of bacterial count in DryStart™ treated pens

crate	Mean
1	28
2	56.5
3	32.5
4	15
5	23
9	24.5
11	57
12	19
13	29
14	18
15	22.5
21	25
22	7
23	29
24	45.5
25	10.5
Total	27.625

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	6306.5	15	420.433333	1.09	0.4300
Within groups	6159	16	384.9375		

Summary of bacterial count in control pens

crate	Mean
6	57.5
7	79
8	90
10	400
16	57
17	27.5
18	52
19	24.5
20	165
26	96.5
27	66
28	40
29	31
30	72

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	241109.407	13	18546.8775	39.31	0.0000
Within groups	6134	13	471.846154		
Total	247243.407	26	9509.36182	Total	
12465.5	31	402.112903			

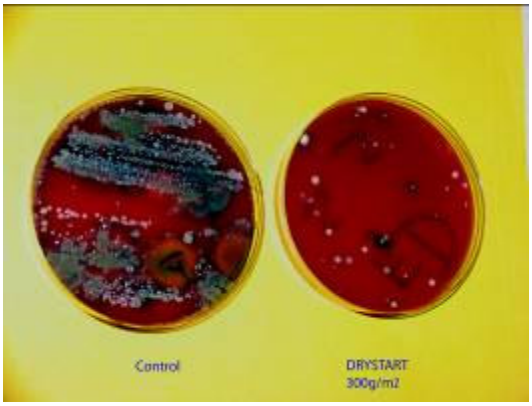

Figure 2 an example of bacterial load from a treated vs untreated crate

There was a tendency to see more fungal colonies in the DryStart™ treated pens vs control, but the difference was not significant

fungus	treatment Control	DryStart™	Total
Negative	26	26	52
Positive	1	6	7

Total		27	32	59

Conclusions to date
In this study:

Whether it is through increased drying efficiency, or some other antibacterial effect, the use of DryStart™ did reduce total bacterial load in finishing pens more effectively than common disinfectants.

The application of DryStart™ on top of conventionally washed and disinfected farrowing crate floors, on average, cut the bacterial load significantly. Treated pens had 3 times fewer bacteria than untreated pens. The severity of many diseases is dependant on the initial dose animals are exposed to. It is logical to expect that DryStart™ treated pens would have a lower incidence of disease.

There was variation between crates and between farrowing rooms only in untreated pens. Washing and disinfection is an imperfect process, there will be bacterial load variation, operator differences, and differences in how well individual crates/rooms will dry. It appears that DryStart™ may eliminate some of the operator and facility differences and take all the crates to common level of hygiene.