Sanitation of Low Temperature Home Laundry

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Introduction

The pressures of sharply higher fuel prices and increasingly scarce supplies are causing consumers to consider each operation requiring energy in the home as a possible source of conservation. Often the recommendation is made for the use of cold water for laundry as a means of home energy conservation. Seldom is it mentioned that sanitation of laundry may be a problem when low water temperatures are used.

Approximately 95% of the direct energy consumed in laundering a load of clothes in a hot wash/warm rinse situation is consumed in raising the water temperature to those levels (1). Surveys show consumers are changing their laundry habits to use lower temperatures in response to the current energy situation (2).

For many years the spread of microorganisms by fabrics has been recognized as a potential health hazard. Clothing can be capable of transmitting disease as it is a suitable environment for growth of microorganisms (3). Studies have shown that sanitation of contaminated clothing can be extremely important. Although good defenses against bacteria disseminated by textile materials are possessed by most humans, a reduced resistance exists among the very young, the elderly and the ill. The possibility of bacteria being transmitted from one person to another is even greater today with the increased use of cold water for laundry and the higher use of public laundry facilities (4).

Purpose of the Study

The problem investigated in this study was the effect varied concentrations of detergents and disinfectants have on sanitation of household textiles laundered in water of low temperature and dried in an automatic dryer. A cooperative project was developed and carried out jointly with the Textile Research Department at South Dakota State University, where the effect of low temperature laundering on soil removal and energy consumption was studied, the research being reported was completed by the Textiles and Clothing Department in cooperation with the Department of Bacteriology at North Dakota State University. The Agricultural Experiment Stations at the respective universities funded the project.

The following objectives were investigated: (a) to determine the effect of type and concentration of detergent on bacterial survival on textiles laundered in water of low temperature and dried in an automatic dryer; (b) to determine any interaction of type and concentration of detergent and disinfectant on bacterial survival on textiles laundered in water of low temperature and dried in an automatic dryer; (c) to determine the effect of varied concentrations of detergents and disinfectants on bacterial survival in wash and rinse solutions and (e) to determine survival of bacteria in the Launder-Ometer cylinders after low temperature laundering.

The following variables were considered:

1. Water Temperature
   a. cold (65°F ± 5)
   b. warm (105°F ± 5)

2. Drying Temperature
   a. low - air cycle (75°to 80°F)
   b. high - normal cycle (140° to 160°F)

3. Detergent Type and Concentration
   a. anionic phosphate granular detergent (Tide): low - 0.10%; medium - 0.15%; high - 0.20%
   b. nonionic non-phosphate liquid detergent (Dynamo): low - 0.045%; medium - 0.09%; high - 0.18%

4. Disinfectant Type and Concentration
   a. chlorine: low - 100 ppm; medium - 200 ppm; high - 300 ppm
   b. quaternary ammonium compound: low - 100 ppm; medium - 200 ppm; high - 400 ppm

5. Fabric Type:
   a. 50% polyester/50% cotton blend percale sheeting
   b. 100% cotton terry cloth toweling

6. Bacterium: *Escherichia coli (E. coli)*

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EXPERIMENTAL PROCEDURES

The procedure was developed to closely simulate the home laundry process. It measured the ability of the entire laundry process to remove bacteria from fabrics, including the mechanical action of washing, rinsing and tumble drying.

Fabric specimens were inoculated with *E. coli* and laundered in 100 ml of the selected wash solutions in a Launder-Ometer. The Launder-Ometer is an electrically operated laboratory testing machine used for making reliable and reproducible tests under controlled conditions of agitation and temperature. Wash solutions were prepared by adding the weighed detergent and/or disinfectant in low, medium or high concentrations to distilled water.

Test Organism

E. coli was chosen since it is a bacterial indicator of other intestinal disease producers found in water, food and clothing contamination studies (5). A broth culture was used to inoculate the fabric specimens for each laundry procedure.

Detergents

Low, medium and high concentrations of the detergents were used, with the medium concentration being the manufacturer's recommendation for normally soiled clothing. The detergent types chosen for use in the study were an anionic phosphate and a nonionic non-phosphate.

An anionic phosphate detergent is a negatively charged synthetic compound which works to emulsify oil, suspend dirt particles, maintain proper alkalinity and soften water (6). The phosphate detergent (Tide) chosen leads in sales at supermarkets (7).

A nonionic detergent is a synthetic compound that has neither a positive or negative charge (6). It may be mixed with other compounds with no difficulty. The non-phosphate detergent (Dynamo) selected is of this type and is a heavy duty liquid detergent with a new type of surfactant system claiming to be unaffected by water hardness.

Disinfectants

The disinfectants selected for use in this study were a quaternary ammonium compound and chlorine in the form of liquid bleach. The low, medium and high concentrations of these disinfectants, determined by the manufacturer's recommendations, were used in combination with the detergents.

The chlorine disinfectant (Clorox) leads other bleaches in sales. The quaternary disinfectant (Sani-T-10, Spartan Chemical Co.) is sold mostly for industrial purposes. It was necessary to add this product in the rinse as it carried a positive charge which would react with the detergent in an undesirable manner. The company claims this product works as a deodorizer and fabric softener as well as a sanitizer.

Fabric

Polyester/cotton sheeting and cotton terry cloth were selected as two fabrics commonly laundered in the home. The fabrics were cut to a 2¼" circular size and soiled prior to laundering, using a procedure for adding both an oily and clay soil to the fabric (8).

Inoculating, Laundering and Plating

Inoculated specimens were placed in the Launder-Ometer cylinders containing the various sterilized wash solutions. Following the 10 minute wash period, fabric specimens were placed in flasks containing the rinse solutions. After rinsing, the fabrics were pressed onto plates containing a medium which allows the bacteria to grow. Wash and rinse solutions were also plated. All plates were incubated for 24 hours. Bacterial growth was counted and recorded. A more detailed explanation of methods and data collection including actual bacteria counts is available in the Master's thesis at the library at North Dakota State University (9).

Analysis of the Data

The data were statistically analyzed, using the analysis of variance procedure (10). This test determined which variable interactions had a significant effect on the numbers of bacteria surviving treatment. The following discussion and figures regard those interactions which were significant at the .05 level.

Results and Dicussion

Only those variables found to be significant by the statistical analysis will be included in the discussion.

Effect of Type and Concentration of Detergent

When water of low temperature was used in the laundry procedure, the use of detergent alone was not effective in sanitizing fabrics. Bacterial counts were lower when nonionic non-phosphate detergent was used on the terry cloth, whereas the polyester/cotton sheeting showed anionic phosphate detergent to be slightly more effective in reducing counts. Detergent concentration did not produce a significant effect in any of the interactions. Bacterial survival was not affected by the amount of detergent used. Bacteria counts obtained when either anionic phosphate or nonionic non-phosphate detergent was used were similar to counts where no detergent was used.

Wash Temperature

Raising the wash water temperature from cold to warm reduced slightly the number of bacteria surviving the treatment. Temperature of water used in laundering is an important factor in bacterial control. Increasing the water temperature from 65° F to 105° F was not sufficient in itself to reduce bacterial counts to an acceptable level.

Drying Temperature Interactions

Drying temperature and its interaction with other factors resulted in a consistent significant effect. Bacterial counts of *E. coli* were reduced by the higher temperature but the bacteria were not eliminated. The 160° F drying temperature would not be effective in controlling other genera of bacteria, such as spore formers, that are much more heat resistant than the *E. coli* used in this study.

Bacterial counts were similar for both detergents at the low drying temperature. At the higher drying temperature counts decreased for both detergents, with the phosphate detergent dropping more sharply than the non-phosphate, as illustrated in Figure 1.

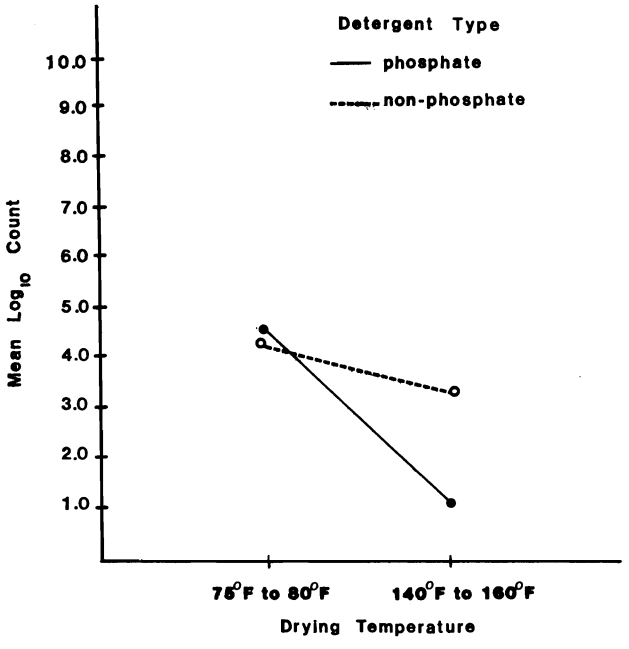

FIG. 1. Mean Bacterial Counts on Polyester/Cotton Sheeting Showing Interaction of Detetgent Type and Drying Temperature.

When the interaction of wash temperature and drying temperature was considered, both cold and warm wash counts were higher at the low drying temperature, as shown in Figure 2. Fabric laundered in cold water and dried at the higher temperature resulted in considerably lower counts than drying at the low temperature. When warm water was used, only a small change occurred attributable to drying temperature.

Detergent and Disinfectant Interaction

Bacterial counts were significantly reduced by the use of both types of disinfectant. As the concentration of the disinfectant increased. bacterial counts were reduced, with the medium concentration resulting in an acceptable level of reduction.

The interaction of detergent type with disinfectant concentration resulted in a similar reaction for both

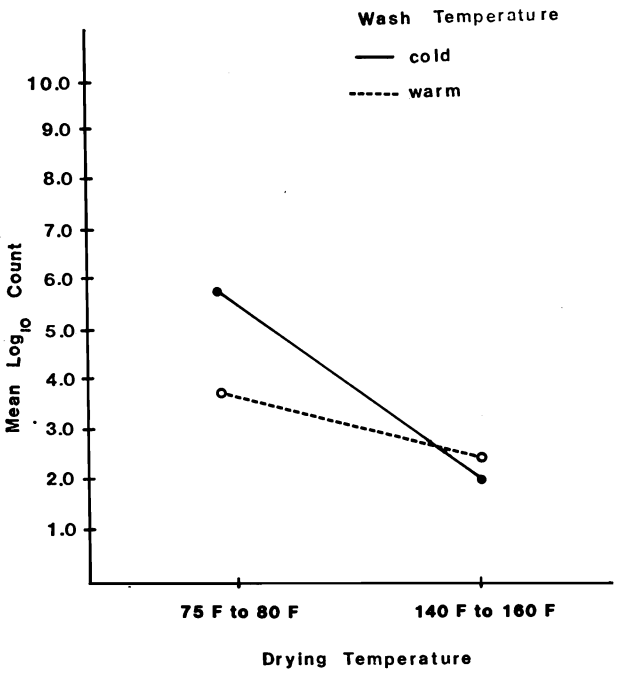

FIG. 2. Mean Bacterial Counts on Polyester/Cotton Sheeting Showing Interaction of Wash Temperature and Drying Temperature.

detergents (Figure 3). As the disinfectant concentration increased, bacterial counts for both detergents decreased. The non-phosphate detergent resulted in lower counts of *E. coli* at the low disinfectant concentration.

Wash water temperature and disinfectant concentration also demonstrated a significant interaction as

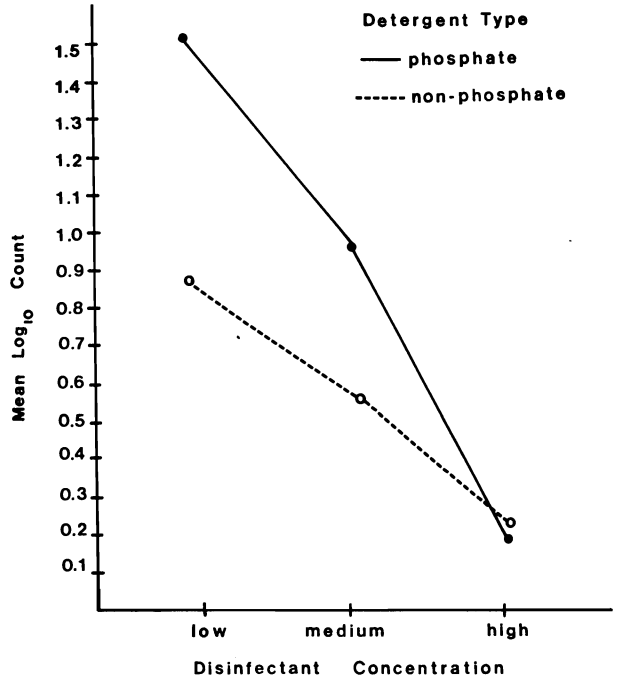

FIG. 3. Mean Bacterial Counts on Terry Cloth Showing Interaction of Detergent Type and Disinfectant Concentration.

shown in Figure 4. This appeared to result from the difference in bacterial counts at the medium disinfectant concentration, where the cold water temperature demonstrated a higher count. Bacterial counts were similar at the low and high disinfectant concentations.

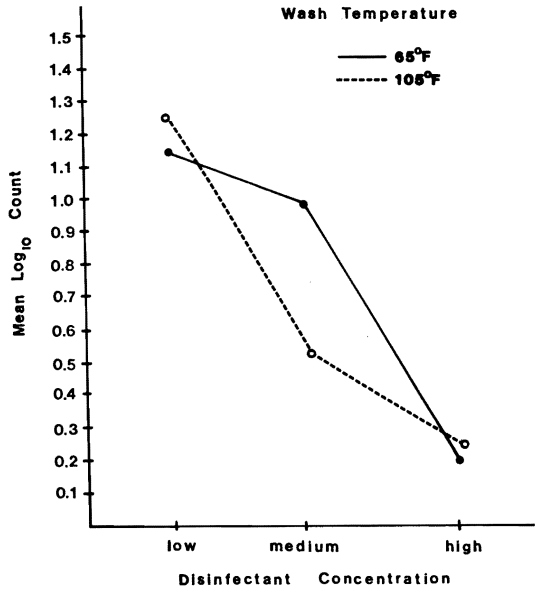

FIG. 4. Mean Bacterial Counts on Terry Cloth Showing Interaction of Wash Temperature and Disinfectant Concentration.

The interaction of drying temperature with disinfectant concentration also was significant. At all three concentrations bacterial counts were lower than for other interactions. For both drying temperatures counts were near zero at the medium and high disinfectant concentrations as shown in Figure 5.

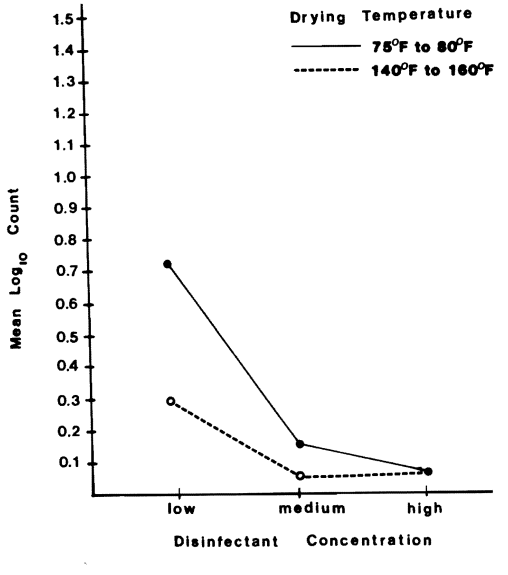

FIG. 5. Mean Bacterial Counts on Cotton/Polyester Sheeting Showing Interaction of Drying Temperature and Disinfectant Concentration.

Survival in Launder-Ometer

Launder-Ometer cylinders were swabbed and streaked on agar plates to determine survival of *E. coli* during the various treatments. Results were similar to those obtained for the wash and rinse solutions. When only detergent was used, the bacterial count was comparable to that obtained when no detergent was added to the wash solution. The addition of either the chlorine or quaternary disinfectant resulted in zero counts for nearly all concentrations.

Summary

1. The use of detergent alone was not effective in sanitizing fabrics when water of low temperature was used in the laundry.

2. Detergent concentration had no effect on the numbers of bacteria surviving treatment.

3. The nonionic non-phosphate detergent resulted in lower bacterial counts when used on the terry cloth, whereas the anionic phosphate detergent was slightly more effective on the polyester/cotton sheeting.

4. The number of bacteria surviving treatment was reduced slightly by raising the wash water temperature from 65°F to 105°F.

5. Use of a disinfectant significantly reduced bacteria counts.

6. Increasing the disinfectant concentration reduced bacteria survival with the medium concentration providing an acceptable level of reduction.

7. Drying at 160°F yielded lower counts than drying at 80°F.

The anionic phosphate detergent used in the study was Tide (6.1% phosphorus). The non-ionic non-phosphate detergent used was Dynamo. Selection was made based on volume of sales at super markets. No endorsement is intended by identification of brand names.

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