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Determination of Biofilms on Plastic Cutting Boards

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Cover Page Footnote
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Introduction

A biofilm is an assemblage of microbial cells that are irreversibly associated with a surface and enclosed in an extracellular polymeric substance matrix (Donlan, 2002). Numerous researchers have observed that microorganisms can attach to and grow on solid surfaces. Zottola, 1994 described biofilm formation on food processing surfaces in three distinct stages; 1) the bacteria attach to the surface, 2) the bacteria consolidate at the surface, often forming polymer bridges, and 3) bacteria colonize the surface, growing and spreading over the surface. The second stage is important in that the bacteria produce an extracellular material that 'cements' the organism to the surface. Microbial colonization on a surface appears to increase as the roughness of the surface increases (Donlan, 2002).

Bacteria in a biofilm are not easily removed by rinsing and sanitizing procedures (de Beer, et al. 1994; Deibel, 2002; Ryu and Beuchat, 2005). Numerous researchers have examined food processing contact surfaces such as stainless steel (Ryu and Beuchat, 2005) but no research has been reported on biofilm formation on plastic cutting boards used in a foodservice/commercial food preparation kitchen setting.

The purpose of this experiment was to determine the aerobic plate count on plastic cutting boards that were used in a food preparation kitchen before and after proper cleaning and sanitizing procedures. If microorganisms remained on the surface of used plastic cutting boards after cleaning and sanitizing, then it would be assumed that a biofilm had been formed on the surface.

Methods

Fifteen plastic cutting boards from a food preparation kitchen were obtained for this study. The plastic cutting boards were first analyzed dry; after the plastic cutting board was used the previous day, washed, sanitized and stored. After the first analysis, the plastic cutting boards were sanitized in a commercial dishwasher (Hobart commercial washer SR24H) which washes, rinses and sanitizes the cutting boards using a commercial detergent for washing (Ecolab Super Trump detergent 12740) and sanitizes with water at 82^0C (180^0F). The plastic cutting boards were air dried prior to sampling after the sanitation procedure. As a control, a new unused plastic cutting board was used following the same procedure as the plastic cutting boards that were used in the food preparation kitchen.

To determine the microbial load on each plastic cutting board, a 25cm^2 surface area, randomly selected at 3 locations on each plastic cutting board, was swabbed with Sterile cotton-tipped swabs (Fisher) wetted with peptone water

(Difco BD). Contaminated swabs were placed into 99 ml buffered peptone water (Difco BD) tubes. The organisms collected from the surface were resuspended from the swab by a mild mixing, using a vortex, for seven seconds. This solution was serially diluted in buffered peptone water (Difco BD). Duplicate pour plates using Plate Count Agar (Difco BD) were prepared at the proper dilutions, and incubated for 48 hours at 37°C. Only those plates with colony numbers in the range of 25 – 250 CFU were counted using a standard Quebec Dark-filed Colony Counter (Leica, Buffalo, NY).

Data were entered into SAS (SAS Institute, 2003) and means, standard deviation and a student t test were conducted on the average aerobic plate count for the plastic cutting boards before and after sanitation.

Results and Discussion

The average aerobic plate count for the plastic cutting boards before sanitation was $1.31 \times 10^4 \pm 2.00 \times 10^4$ CFU/25 cm^2. After sanitation of the plastic cutting boards, the average aerobic plate count was $1.35 \times 10^3 \pm 1.91 \times 10^3$ CFU/25 cm^2. The control plastic cutting board did not contain any microorganisms initially or after the sanitation procedure. The washing and sanitizing procedure that we followed are typical of practices used in foodservice/commercial food preparation kitchens. A one log reduction in aerobic plate count before and after sanitation was statistically significant but 3 logs of microorganisms still remained on the surface after sanitation. The standard deviations are large due to the number of potential microorganisms in the different locations of the cutting board. The center of the cutting board gets more use than the corners, therefore there is more potential for more organisms and a biofilm to develop in the center of a cutting board versus the corners. Our initial method to analyze the plastic cutting boards was to lightly scrape the surface of the plastic cutting board and plate that on plate count agar. The amount of microorganisms that grew was difficult to enumerate as the organisms clustered around the scrapings and were higher than initially expected. We then decided to firmly swab a 25 cm^2 area to determine a microbial count. Again the number of microorganisms was very high and dilutions were made from the swab to determine a countable sample. Therefore, we suspect that a biofilm had formed on these plastic cutting boards. A picture of one of the plastic cutting boards appears in Fig. 1. Most of the plastic cutting boards used in this study had discoloration and noticeable cuts where a biofilm could easily develop.

Figure 1. Example of a plastic cutting board from a food preparation kitchen used for analysis in this study.

Depending on the type of microorganism(s) that remains on the surface of a plastic cutting board, a potential food borne illness could result if a pathogen is transferred to an uncooked food that is prepared on one of these plastic cutting boards. Donlan (2002) reported that some pathogens are associated with and grow in biofilms. These organisms are *Listeria monocytogenes, Campylobacter* spp., *E.coli* O157:H7, *Salmonella typhimurium*, and *Vibrio cholerae*.

The plastic cutting boards from the food preparation kitchen were washed, rinsed and sanitized after use the day prior to analysis. Since the sanitation procedure in our study only removed one log of organisms, the sanitation the day before should have removed one log also but existing organisms on the plastic cutting boards could have increased one log during the one day storage. If improper washing occurred and plastic cutting boards were stored wet, these conditions provide adequate moisture and the food supply for microorganisms to grow and multiply.

The procedure for washing, rinsing and sanitizing in our study is the standard procedure for foodservice equipment in a foodservice/commercial food preparation kitchen (FDA, 2005). A consumer article provided methods for routine cleaning of cutting boards and removal of stains from plastic cutting boards (McManus, 2008). For routine cleaning the author recommended to either scrub the cutting board thoroughly in hot, soapy water or put it through the dishwasher which would be the standard method recommended for foodservice operations also. To remove stains from plastic cutting boards, she recommends soaking the stained plastic cutting board overnight in a bleach bath of one tablespoon of bleach per quart of water and immerse the board, fouled-side up (McManus, 2008). When the board floats to the surface, cover it with a clean white kitchen towel and splash the towel with ¼ cup of additional bleach. The method for removing stains is not a standard practice in foodservice/commercial food preparation kitchens. Future research could focus on whether this stain removal method reduces the microbial load of the discolored and scarred plastic cutting boards and to determine if this is a satisfactory method to recommend to the foodservice industry.

Conclusions

The results of our study indicate that plastic cutting boards used in a foodservice/commercial food preparation kitchen with discoloration and deep scars from knives could support a biofilm. Initially a four log aerobic plate count was noted on the plastic cutting boards with a one log reduction after proper washing, rinsing and sanitizing. Discolored and heavily scarred plastic cutting boards need to be replace or resurfaced to prevent cross-contamination of this biofilm to food.

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