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The Survivability of Microorganisms on Kitchen Surfaces

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ABSTRACT
Antibacterial surfaces are surfaces that can resist bacteria, relying on the nature of the material itself. Antibacterial surfaces are essential for food and water safety, human health, and industrial equipment. The most common type of bacterial contamination on the material surface is biofilm. Antibacterial surfaces may be developed more effectively by preventing the production of biofilm. When basic hygiene procedures are applied on kitchen surfaces, germs adhered to these surfaces are not apparent to the naked eye and may thus not be totally eradicated. In this study the survivability of *Escherichia coli* and *Bacillus cereus* on Star Galaxy granite, Muğla white marble, Denizli travertine, and stainless steel which are commonly used in kitchen work surfaces, was evaluated using the swap method. The results showed that long time survival of microorganisms is affected by drying and all kitchen surfaces have been evaluated for this aspect.
Keywords: Antibacterial, Antimicrobial, Coating, Hygiene

INTRODUCTION
Improvements in hygiene techniques around the world have resulted in a lower rate of infectious diseases. In addition to transmission through infected people or animals and polluted air, contaminated materials play an important role in the spread of infectious diseases. As a result, the hygienic properties of material surfaces are critical (Beumer and Kusumaningrum, 2003; Rayner et al., 2004). Bacteria, as the most prevalent organisms on Earth, exert a substantial influence on various aspects of human activities, including industrial processes and human well-being (Singh, 2009; Teusink and Smid, 2006). Nevertheless, the considerable obstacles posed by bacteria present a significant challenge. For instance, bacteria pose risks to the quality and safety of food and water, leading to a wide range of human illnesses. Bacteria live not only in the bulk phase, but also on surfaces, where they may grow, proliferate, and disseminate. Surfaces with antibacterial properties can prevent the initial attachment of bacteria in two ways: by displaying an antibiofouling effect that rejects or inhibits bacterial adhesion, or by inactivating any cells that come in contact with the surface, leading to cell death and exhibiting a bactericidal effect. Therefore, antibacterial surfaces can be broadly categorized as either antibiofouling (Chung et al., 2007) or bactericidal (Tiller et al., 2001; Ivanova et al., 2012). Antibiofouling surfaces achieve resistance or inhibition of bacterial adhesion through features such as microorganism-unfavorable surface topography or chemistry (Ivanova et al., 2011; Mrabet et al., 2009). Bactericidal surfaces, on the other hand, induce cell death upon contact with bacteria (Tiller et al., 2001). In certain cases, an antibacterial surface may possess both antibiofouling and bactericidal properties. The kitchen counters serve as a focal point in the kitchen for food preparation. Because of their strength, endurance, and simplicity of manufacturing, granite, white marble, travertine, and stainless steel have been popular materials for kitchen counter tops. Black Galaxy granite, a recent addition to the range of construction materials, was discovered in the late 1970s or early 1980s. Since then, it has gained immense popularity worldwide due to its exceptional durability and captivating aesthetic appeal (Web Anonym 1, 2023). Travertine is a type of limestone that originates from mineral springs, specifically hot springs, on land. It exhibits a distinctive appearance with its fibrous or concentric patterns and is available in various colors such as white, tan, cream, and even rusty shades (Jackson and Bates, 1997). One of the many benefits of

travertine tile is that it is easy to maintain. Marble is a type of metamorphic rock that undergoes recrystallization under the influence of heat, pressure, and aqueous solutions. It is primarily composed of carbonate minerals, namely calcite (CaCO3) or dolomite (CaMg(CO3)2), and possesses a varying thickness of crystalline structure (Britannica, 2022). Stainless steel has been the favored choice for kitchen worktops and sinks for numerous years, primarily due to its mechanical strength, corrosion resistance, long lifespan, and ease of manufacturing (Holah and Thorpe, 1990). Its ability to retain hygienic properties over an extended period in domestic settings is attributed to its resistance to damage from abrasion or impact (Holah and Thorpe, 1990; Stevens and Holah, 1993). When basic hygiene procedures are applied on kitchen surfaces, germs adhered to these surfaces are not apparent to the naked eye and may thus not be totally eradicated. In this study the survivability of *Escherichia coli* and *Bacillus cereus* on Star Galaxy granite, Muğla white marble, Denizli travertine, and stainless steel which are commonly used in kitchen work surfaces, was evaluated using the swap method.

METHOD AND MATERIALS

Materials

Escherichia coli (ATCC 25922) and *Bacillus cereus* (ATCC 7064) were used in the evaluation of the surfaces antibacterial effectivity. Six different types of materials used in kitchen work surfaces (Star Galaxy granite, Muğla white marble, Denizli travertine, and stainless steel) from commercial sources.

Samples Preparation

All countertop materials were obtained from a home furniture shop. All surfaces were not applied any coating. Within the scope of the study, the surface materials were cut into (5cm x 3cm) samples and sterilized using autoclave and bacterial suspensions were sprayed on the surface and let dry in room temperature and sampling was made after 24 hours of bacterial attachment.

Microbial Analyses

In this study, strains of *E. coli* (ATCC 25922) and *Bacillus cereus* (ATCC 7064) were used to contaminate four kitchen countertop surface samples (5 cm x 3 cm) of Star Galaxy Black Granite, Stainless Steel, Muğla White Marble, and Denizli Travertine. Following contamination, the surface was left for 24 hours before swab sample was repeated. The findings were calculated as $\log_{10}$kob/cm^2 after serial dilutions were produced with maximum recovery diluent, inoculated on plate count agar using the spread plate technique, and incubated at 37°C for 24 hours.

RESULTS AND DISCUSSION

Microorganisms found in food are the leading source of foodborne diseases, including infections and intoxications, which are frequently caused by contamination of kitchen surfaces during food preparation. Kitchens at restaurants, hotels, schools, and food processing facilities should be structured to reduce the danger of microbiological contamination and cross-contamination. The data obtained from Star Galaxy Black Granite, Stainless Steel, Muğla White Marble, and Denizli Travertine at the end of 24 hours are shown in Table 1.

Table 1. the survivability of Escherichia coli and Bacillus cereus on Star Galaxy granite, Muğla white marble, Denizli travertine, and stainless steel.

Sample	***E.coli***	***B.cereus***
Control	9,397	9,113
Star Galaxy Black Granite	4,748	5,012
Stainless Steel	7,0128	7,994
Muğla White Marble	4,707	4,505
Denizli Travertine	5,679	5,902

In this context, when the data are interpreted graphically, the linearity of R2 values is observed and the decrease shows statistical significance in certain stones.

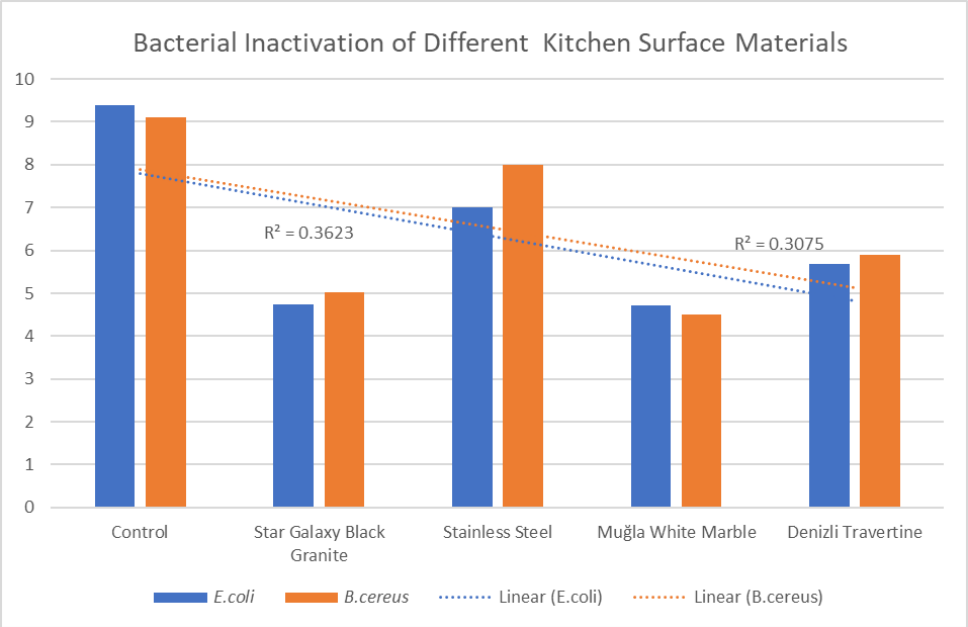

Figure 1. Bacterial inactivation of different kitchen surface materials

The most effective surface was observed to be Star Galaxy Black Granite, followed by Muğla White Marble. In this context, the rates of reduction on the surfaces are shown in Figure 2.

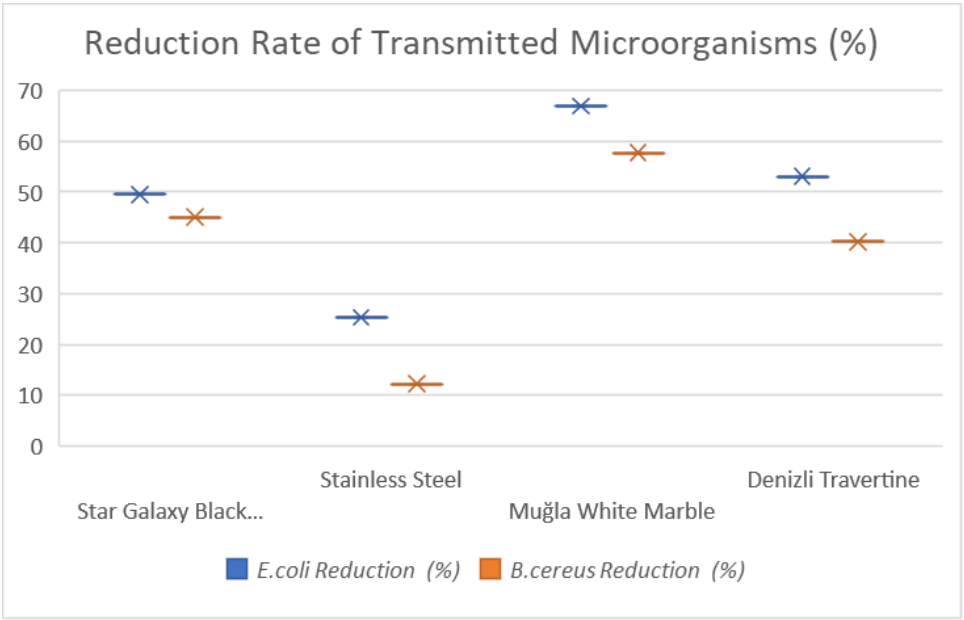

Figure 2. Reduction rate of transmitted microorganisms

Black granite is a durable and elegant surface for countertops, but it does not have inherent antibacterial properties. It needs to be cleaned regularly with a mild soap and water or a granite cleaner to prevent bacteria growth (Collaborative, 2023; Melynn, 2023). Stainless steel is a common material for kitchen appliances and sinks, but it is not antibacterial by itself. Some stainless steel products are treated with antibacterial metal elements or coatings to inhibit bacteria growth (Wolken, 2020; Web Anonym 2, 2023). However, these treatments may wear off over time or be affected by harsh cleaning agents (Web Anonym

2, 2023). White marble is a beautiful and classic stone for countertops and floors, but it is also porous and prone to staining and etching. It does not have natural antibacterial properties and requires sealing and gentle cleaning to prevent bacteria buildup (Web Anonym 3). Travertine is a type of limestone that has a natural and rustic appearance. It is also porous and susceptible to staining and scratching. It does not have antibacterial properties and needs sealing and regular cleaning with a neutral pH cleaner to prevent bacteria growth (Resnik et al., 2020; Web Anonym 4, 2023). Based on this information, none of these materials are inherently antibacterial and they all require proper care and maintenance to keep them hygienic. Some products may claim to have antibacterial features, but they may not be effective or long-lasting. Therefore, it is important to follow the manufacturer's instructions and use suitable cleaners for each material. These data are not showing parallelism with our study due to the industrial testing time is 15 minutes. But we wanted to obtain data about 24th hour which is more important for us for formation of biofilms that can cause infections and longtime antimicrobial effect is not reported in any study. Yamada et al. (2001) evaluated antibacterial metals used in kitchen surfaces using the swap method. The research was conducted over a one-year period. The bacterial population on the antibacterial surface environment was less than 1% of the bacterial population on a conventional surface. The antibacterial metal's ability to reduce germs appears to be strongly connected to temperature and relative humidity. As a result, it was found that using an antibacterial metal on a surface environment can lower the bacterial population by preventing their development based on environmental conditions. Kusumaningrum et al. (2003) studied the survival of foodborne pathogens on stainless steel surfaces and cross-contamination of foods. The study showed that microorganisms may survive on dry stainless-steel surfaces and provide a contamination risk for extended periods of time, depending on contamination levels and pathogen type. In the scope of this study tests performed allowed to confirm the antibacterial claims of manufacturers and suppliers, and hence the potential of these surfaces for incorporation in the kitchen of the future. Despite the positive results from Star Galaxy Black Granite was the most effective surface, followed by Muğla White Marble additional hygienic measures are needed.

CONCLUSION

Foodborne illnesses have always been a major concern in kitchens and a never ending problem. It is essential to remain active and committed to infection/poisoning prevention and control in order to achieve and ensure consumers safety. It is expected that the antimicrobial surfaces field keeps attracting more and more researchers in view of the potential impact of self-disinfectant surfaces on food safety, health-care related infections and more. However, there is still quite to be done in order to fully understand these surfaces and their real potential. In this study the survivability of *Escherichia coli* and *Bacillus cereus* on Star Galaxy granite, Muğla white marble, Denizli travertine, and stainless steel which are commonly used in kitchen work surfaces, was evaluated using the swap method. It can be said that long time survival of microorganisms is affected by drying and all kitchen surfaces have been evaluated for this aspect. These results are the first in the literature.

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