Evaluation of the effectiveness of a quaternary ammonium-based coating in preventing *Salmonella* cross-contamination

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Introduction

Thousands of outbreaks caused by contaminated water or food are reported every year. In Europe, it is estimated that in 2019, 40.5% of the outbreaks occurred in the home environment[1]. Domestic kitchens plays an important role in the transfer of foodborne disease-causing agents[2] since most consumers use contaminated surfaces and equipment in food preparation[3]. *Campylobacter* spp., *Salmonella* spp., *Listeria monocytogenes*, and *Escherichia coli* are pathogens that are commonly found on these surfaces, as they are transmitted by food, mainly of animal origin. Food contact with these surfaces is a frequent source of cross-contamination[4]. The occurrence of cross-contamination is still very common because when cells adhere to kitchen surfaces, they are not easily removed by common cleaning products [5].

This difficulty in eliminating pathogens from surfaces in order to prevent contamination, together with the lack of consumer knowledge regarding correct food handling techniques, further increases the risk of cross-contamination. Household cleaning products have been incorporating antimicrobial agents (hypochlorite, chlorine dioxide, peracetic acid and aldehydes derived from glutamine) in their composition for several decades and have gained the trust of consumers, as they have a great ability to inactivate microorganisms through chemical oxidation. However, these cleaning products are only in contact with microbial contaminants on surfaces shortly after application[6]. One solution to get longer-lasting protection is through antimicrobial surface coatings.

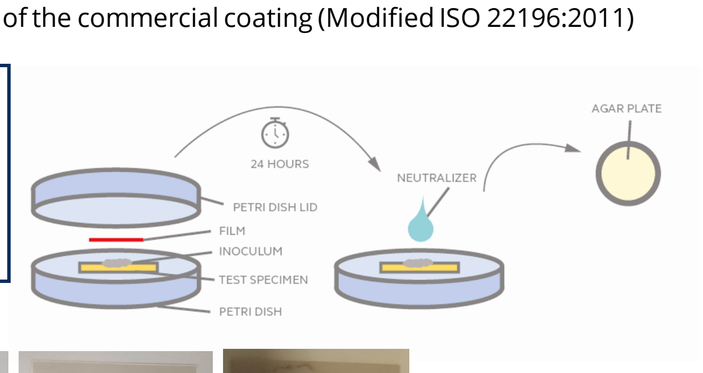
Objective

The objective of the present work was to determine the antimicrobial activity of a quaternary ammonium-based coating spray applied to different surfaces against *Salmonella* spp. and, then, to evaluate its ability to prevent possible cross-contamination.

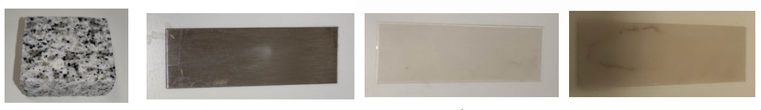
Methods

I. Antimicrobial effectiveness of the commercial coating (Modified ISO 22196:2011)

INOCULUM
($2.5x10^5$ – $1.0x10^6$ UFC/ml)
Salmonella cocktail:
-*Salmonella* Enteritidis ESB37
-*Salmonella* Infantis ESB46
-*Salmonella* Seftenberg ESB45
-*Salmonella* Typhimurium ESB36
-*Salmonella* Typhimurium ESB47



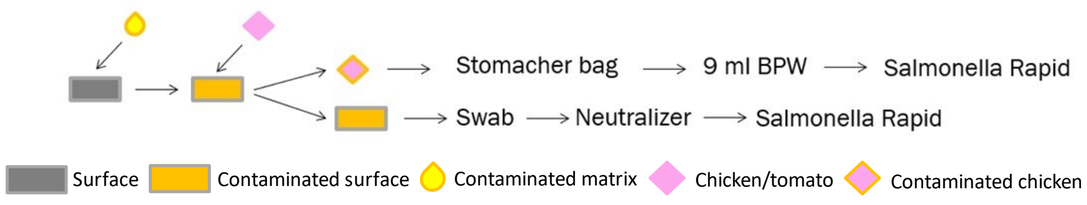
COATED SURFACES



Marble | Stainless steel | Acrylic | Silicone

II. Assessment of cross-contamination inhibition/prevention

Salmonella cocktail at 10^7 UFC/ml)



Results

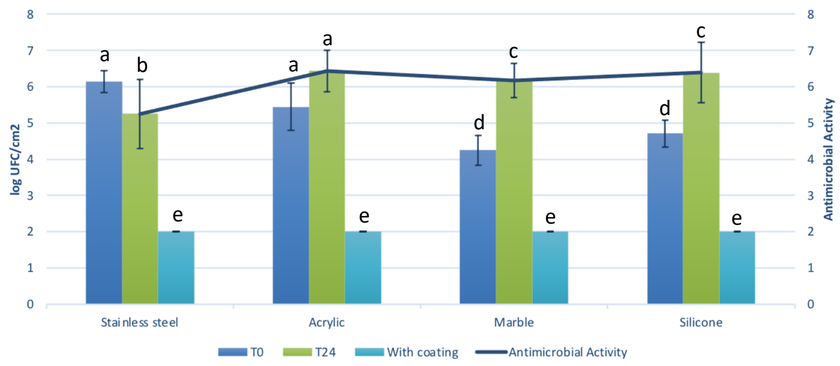


Figure 1. Antimicrobial activity of the coating against *Salmonella*. Results are means based on data from three replicates and standard deviations are indicated by error bars. Equivalent lowercase letters alone mean non-significant differences between each condition (P > 0.05). The dotted line indicates the detection limit of the enumeration technique.

- Significant differences (P < 0.05) were observed between surfaces at **T0**. In stainless steel and acrylic, there was a greater microbial survival at T0, probably due to a lower hydrophobicity presented by these surfaces.
- A decrease in the value of CFU/cm² (P = 0.224) after **T24** on the control surfaces was observed only for stainless steel.
- The **coating** was effective in eliminating *Salmonella* on all surfaces, with counts below the detection limit of the enumeration technique (2 log CFU/cm²).

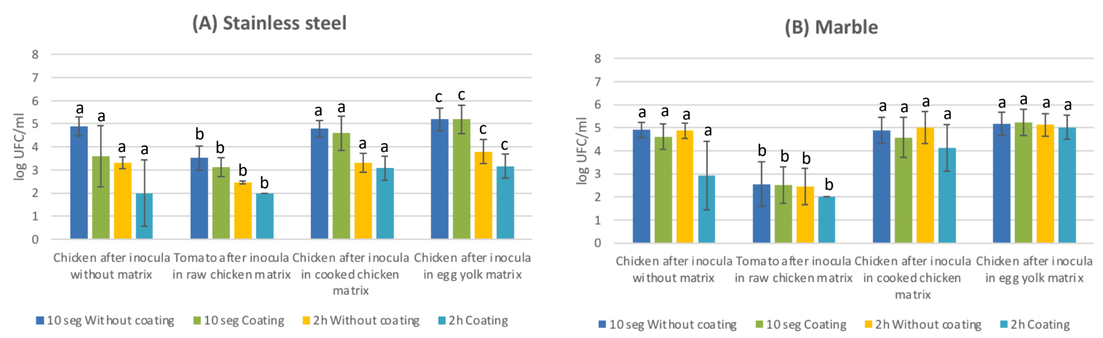


Figure 2. Results of the transfer of *Salmonella* from the surface to the food, after 10sec and 2h of matrix contact with stainless steel (A) and marble (B). Results are means based on data from three replicates and standard deviations are indicated by error bars. Equivalent lowercase letters alone mean non-significant differences between each condition (P > 0.05). The dotted line indicates the detection limit of the enumeration technique.

- The residence time of the matrix on the surface was not a determining factor, since no significant differences were found (P > 0.05) for the two contact times.
- The type of matrix had a relevant impact on the transfer of *Salmonella* to the food.
- Differences between treated and untreated surfaces were only verified in the control of stainless steel.

Conclusions

- When applying the international standard ISO 22196: 2011, a reduction of *Salmonella* to levels below the detection limit was observed on all treated surfaces, demonstrating that the coating has good antimicrobial activity and creates a protective layer on the surfaces.

- However, the coating was not effective in preventing food cross-contamination. The food matrix seems to have been the determining factor for the survival of *Salmonella*, since it provided protection to the bacteria, making it difficult for the coating to act.

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