Microbial investigation of hygienic properties of different plastic and metal surfaces used by the meat industry

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Introduction: The meat and poultry industry still faces challenges related to food safety. Biofilm formation as well as the short-time it takes to cause cross contamination are of special importance when it comes to equipment cleaning (Fryer et al., 2011). The hygienic design of conveyor belts is essential, as belts provide a potential source for foodborne pathogens (Azizkhan, 2014; Barbut, 2016). Various materials are already recommended by equipment manufacturers and guidelines. Nanomaterials provide a promising technology as they are able to keep soil away from the surfaces (Fryer et al., 2011; Khezerlou et al., 2018). The aim of the study was a comprehensive comparison of different conveyor belt materials designated for the meat industry. Common used materials and new nanoporous surfaces were investigated in regard to their cleanability as well as technological and hygienic properties.

Materials and methods: 13 different thermoplastic polymers (PUR, POM, polyoefins), four stainless steels with different surface finishes (electro-/drum-polished, glass-bead blasted rough/fine) and five nanoporous aluminum belts (25-300 nm) were compared with regard to their cleanability, bacterial adhesion properties, roughness and general surface topography. The samples were inoculated with Ps. fluorescens suspension and short-term exposed to 25°C for one hour. Cleaning was performed with distilled water and alkaline detergent (0.1%) in separate experimental set-ups. The reduction of the bacterial load was determined referring to JIS Z 2801. Differences in cleanability were analyzed for significance by Kruskal-Wallis-Test. The surface topography and microstructures were additionally investigated by scanning electron microscopy with appropriate magnifications of 2 µm-1.20 nm.

Results: The percent reduction of the bacterial load for stainless steel and plastic polymers after cleaning with distilled water are in a range from 11.84% to 28.23%. Nanoporous alumina surfaces showed reduction rates of 45.83% to 51.92%. After cleaning with an alkaline detergent, reduction rates ranged from 10.59% for fibrous Polyurethane to 53.48% for nanoporous aluminum with a microstructure of 40 nm. Cleanability rates of all investigated surfaces showed significant to high significant differences ($p=0.05$ and $p=0.01$). In general, the individual cleanability rates depended on surface characteristics as roughness, type of finish (for stainless steel) or pore size (for nano surfaces). Employing scanning electron microscopy was useful in predicting rates of cleanability.

Conclusions: The cleanability of surfaces not only depends on one decisive criteria, but rather the interaction of bacterial adhesion characteristics, roughness and surface topography. Nanoporous aluminum can provide a promising application for machinery in the food industry due to positive effects on the bacterial attachment and therefore cleanability. New materials can prevent cross-contamination, improve food safety and reduce cleaning costs. Furthermore, a sustainable and more environmental friendly process can be increased due to shortened cleaning procedures, less chemicals and less corrosion.

Literature:

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