miki GREEN care



PROBIOTIC CLEANING

A paradigm shift in health hygiene.

PROBIOTIC CLEANING - A PARADIGM SHIFT IN HEALTH HYGIENE.

Probiotic cleaning agents have long been used in households and workplaces due to their effective cleaning properties, odor-inhibiting effects, and environmental friendliness.

In recent years, an increasing number of studies have shown that probiotic cleaning products are more effective than chemical disinfection in reducing pathogen load, the number of antibiotic resistance genes, and the incidence of nosocomial infections (NIs).

Experts in the field refer to this as a **"paradigm shift"**: instead of killing the entire microflora with chemical disinfectants, "good" bacteria are deliberately introduced to harness the natural microbiology in combating pathogens in hospital environments.



A sign of the growing recognition of this approach is the fact that Germany's Robert Koch Institute — the central authority for infection control — listed probiotic cleaning as a promising alternative to disinfection in its latest guidelines for surface cleaning in healthcare settings (KRINKO, 2022).

OPERATING PRINCIPLE

Probiotic cleaning agents contain, in addition to the „beneficial" microorganisms, detergents that dissolve dirt, similar to conventional cleaning agents. Furthermore, organic acids are included to lower the pH value and improve cleaning efficiency, as well as nutrients (prebiotics) that sustain the probiotic bacteria.

The probiotic microorganisms are adaptable to various environments and food sources, and, of course, are completely apathogenic. Strains of the genus *Bacillus* are almost always included, but *Lactobacillus* spp. (lactic acid bacteria) and *Saccharomyces* spp. (yeasts) are also common. The *Bacillus* genus can form so-called endospores — a dormant state without metabolism.

These spores are highly resistant and can remain inactive for long periods, only to germinate and return to their normal cellular form when favorable conditions arise.

Probiotic cleaning agents consist entirely of natural ingredients that are 100% biodegradable. The included surfactants are often nonionic, so-called sugar surfactants derived from plant-based raw materials. In comparison to disinfectants, probiotic cleaning agents result in a lower chemical load and are a better choice for both the environment and the workplace.

DEEP CLEANING EFFECT

The probiotic bacteria add an extra dimension to cleaning, as they — unlike surfactants — not only dissolve dirt but actually break it down. This activity continues after the actual cleaning process, as long as organic dirt particles are present to serve as „food."

Probiotic bacteria possess a broad spectrum of enzymes capable of breaking down most organic components of dirt. They secrete so-called exoenzymes that break down macromolecules into smaller components, making them easier for the bacteria to absorb and further process in their intracellular enzyme systems. Examples include proteases, lipases, and amylases, which break down proteins, fats, and starch, respectively. In addition, the bacteria can secrete so-called biotensides, which help dissolve stubborn dirt. Due to their small size (in the micrometer range), probiotic bacteria can penetrate microscopic cracks, scratches, and pores that conventional cleaning methods cannot reach.

Biofilms form when bacteria encapsulate themselves in an extracellular polysaccharide matrix and form a thin layer on surfaces — especially in moist environments. These biofilms pose a hygiene problem, as they can harbor pathogens and odor-causing bacteria. Probiotic cleaning has proven effective in breaking down such biofilms and preventing their reformation.

Additionally, probiotic bacteria have an odor-inhibiting effect by breaking down unpleasant metabolic by-products (such as volatile fatty acids, ammonia, and sulfur compounds) produced by odor-causing bacteria.

THE PROBLEM OF NOSOCOMIAL INFECTIONS AND ANTIBIOTIC RESISTANCE

Nosocomial infections (Healthcare-associated Infections, HAI) are the most common patient-related complication in the UK healthcare system. In 2023, a survey by the UK Health Security Agency (UKHSA) found that 7.6% of patients in England had healthcare-associated infections (HAIs). The majority of these infections are caused by antibiotic-resistant bacteria.

The World Health Organization (WHO) classifies multidrug-resistant bacteria as one of the greatest global threats to public health. It warns of a "post-antibiotic era," where even harmless infections could be fatal due to the lack of effective antibiotics.

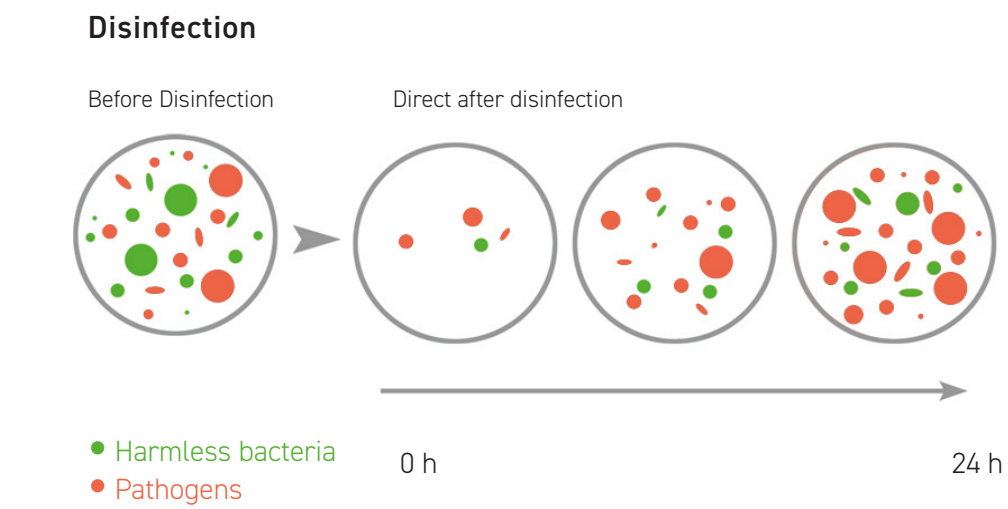
Not only does the excessive use of antibiotics promote the growth of resistant bacterial strains through selective pressure, but the intensive use of chemical disinfectants also contributes to the spread of antibiotic resistance.

The cause is seen in increased horizontal gene transfer: under chemical stress, conjugative plasmids containing resistance genes are more frequently transferred. This significantly accelerates the spread of antibiotic resistance. Studies show that healthcare facilities with particularly intensive use of disinfectants also experience the highest numbers of multidrug-resistant bacteria.

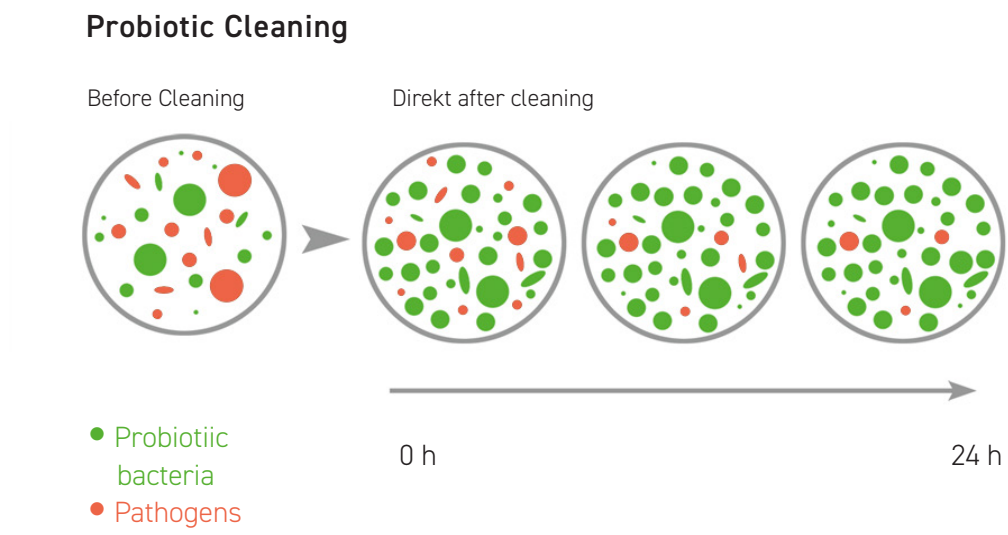
Another problem is the increasing occurrence of bacterial strains that have developed resistance or increased tolerance to conventional disinfectants. Particularly concerning: These bacteria often exhibit cross-resistance to antibiotics, further limiting treatment options.

PROBIOTIC CLEANING AS AN ALTERNATIVE TO DISINFECTION

Chemical disinfectants act broadly and eliminate virtually the entire microbiome on treated surfaces—both pathogens and harmless bacteria. However, the effect is short-lived, and the surfaces are quickly re-colonized by nosocomial (hospital-associated) pathogens due to the lack of competitive pressure from other microorganisms. This has led to a new concept known as **„Bygiene"** (bidirectional hygiene). The focus here is to reduce the pathogen load on critical hospital surfaces while preserving a diverse microflora of harmless microorganisms in the indoor environment. The principle uses the natural microbial ecology preventively: A diverse and stable microbiome provides long-term protection against the growth of pathogens on hospital surfaces.



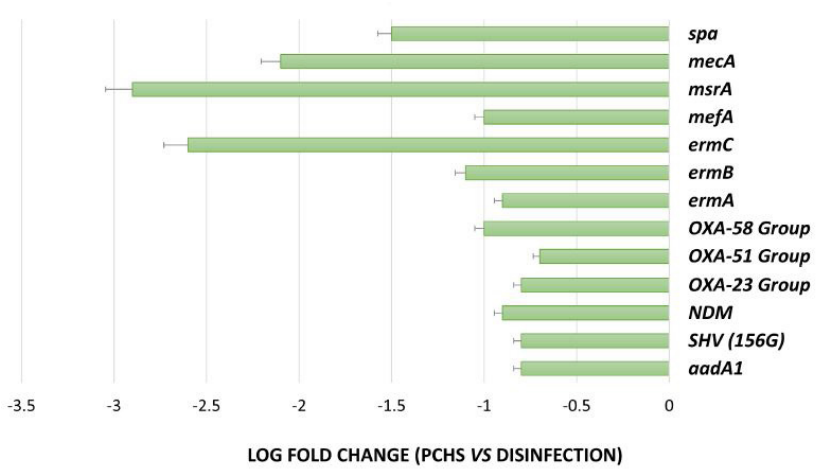
The most important pathogen-inhibiting effect of probiotic microorganisms is based on the principle of competitive exclusion (also known as Gause's Law). Simply put, the adaptable probiotic organisms displace pathogens by depriving them of nutrients and living space. In addition, probiotic bacteria produce a variety of substances that inhibit the growth of pathogens, including: bacteriocins (antimicrobial peptides), antifungals (against fungi), biotensides (surface-active substances), organic acids (e.g., lactic acid, acetic acid), and secondary metabolites (metabolic products that provide additional competitive advantages). Through these mechanisms, probiotic bacteria create an unfavorable environment for pathogens while securing ecological dominance on treated surfaces.



IMPACT ON PATHOGENS, ANTIBIOTIC RESISTANCE, AND HAI INCIDENCE

A large number of in vitro and in situ studies have shown that probiotic cleaning containing Bacillus spp. significantly reduces the nosocomial pathogen load on hospital surfaces more effectively than chemical disinfection. This applies not only to bacteria but also to yeasts (*Candida* spp.) and molds (*Aspergillus* spp.). This reduction is more long-lasting compared to chemical disinfection, whose biocidal effect rapidly diminishes.

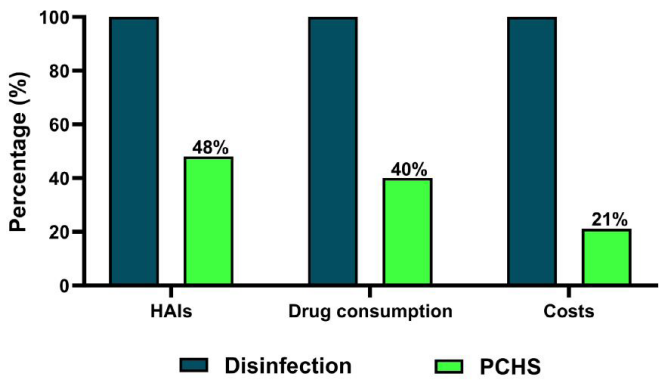
Probiotic cleaning agents have proven to be more effective than chemical disinfection against resistant bacterial strains from the notorious ESKAPE group of the WHO. Probiotic cleaning modulates the resistome of hospital surfaces and significantly reduces the total number of antibiotic resistance genes in the microbiota.



Probiotic Cleaning (PCHS) vs. Disinfection: Effect on Antibiotic Resistance Genes

Professor Caselli from the University of Ferrara and researchers affiliated with her have published a large number of studies on this topic, including the first major in situ study with epidemiological follow-up of HAI (Healthcare-associated Infections) incidence (Caselli et al., 2018). The study was conducted over 18 months at six different hospitals in Italy and included nearly 12,000 patients, comparing probiotic cleaning with sodium hypochlorite disinfection.

Probiotic cleaning reduced the cumulative HAI incidence by more than half compared to chemical disinfection. An economic analysis of the results showed that the reduced HAI incidence led to a 60% reduction in antibiotic consumption and a 79% decrease in associated healthcare costs. Similar positive results regarding HAI incidence (a 56% reduction) were reported in a smaller study in a burn unit in Cape Town.



Probiotic Cleaning (PCHS) vs. Disinfection: Impact on HAI Incidence, Associated Medication Use, and Healthcare Costs

A large study with nearly 14,000 patients was conducted at the Charité University Hospital in Berlin, comparing probiotic cleaning, disinfection, and traditional surfactant-based cleaning agents (Leistner et al., 2023). In this study, probiotic cleaning and chemical disinfection yielded the same result regarding HAI (Healthcare-associated Infection) incidence, which can likely be explained by the very low baseline level of HAI prevalence in the tested wards.

Probiotic cleaning also has an antiviral effect, and in vitro tests showed that probiotic cleaning inactivated, among others, coronaviruses (including SARS-CoV-2), herpesviruses, influenza viruses, and vaccinia viruses within 1-2 hours.

Notably, probiotic cleaning maintained its antiviral effect much longer than ethanol and sodium hypochlorite. An in situ study in a pediatric emergency department during the Covid-19 pandemic showed that probiotic cleaning kept the frequency of SARS-CoV-2 viruses at detectable levels. A possible explanation for the virus inactivation ability is that the enzymes of the probiotics (especially lipases) can break down the lipid envelopes of enveloped viruses.

The properties of probiotic cleaning agents are naturally of great interest in other public environments



where there is a high risk of infection spread, such as public transportation or daycare centers. A study in subway cars in Milan showed that probiotic cleaning significantly reduced the frequency of pathogens, antibiotic resistance genes, and SARS-CoV-2 viruses compared to hypochlorite.

REFERENCES

Commission for Hospital Hygiene and Infection Prevention (KRINKO) at the Robert Koch Institute (2022)
Requirements for Hygiene in the Cleaning and Disinfection of Surfaces: Recommendations from the Commission for Hospital Hygiene and Infection Prevention (KRINKO) at the Robert Koch Institute. *Bundesgesundheitsblatt - Health Research, Health Protection.* 2022; 65 (10): 1074–115.

Caselli E, Brusaferro S, Coccagna M, Arnoldo L, Berloco F, Antonioli P, et al. (2018)
Reducing Healthcare-Associated Infection Incidence by a Probiotic-Based Sanitation System: A Multicenter, Prospective, Intervention Study. *PLoS One,* 13, e0199616.

Leistner R, Kohlmorgen B, Brodzinski A, Schwab F, Lemke E, Zakonsky G, Gastmeier P. (2023)
Environmental Cleaning to Prevent Hospital-Acquired Infections on Non-Intensive Care Units: A Pragmatic, Single-Center, Cluster Randomized Controlled, Crossover Trial Comparing Soap-Based, Disinfection, and Probiotic Cleaning.
EClinical Medicine, 59, 101958.

APPLICATION IN HEALTHCARE

Probiotic cleaning agents can generally always be used as an environmentally friendly substitute for traditional cleaning agents and, to a large extent, can replace chemical disinfectants.

However, in situations where immediate decontamination is required, disinfection remains necessary and cannot be replaced by probiotic cleaning agents, such as in point disinfection of infectious spills like bodily fluids.

Chemical disinfection has an immediately effective but rapidly fading biocidal effect. Probiotic organisms, on the other hand, require an acclimatization phase to adapt to the environment, which means their effect against pathogens is not immediate (but longer-lasting). Probiotic cleaning agents are more preventive in their function than disinfectants.

In rooms of hygiene classes 0-2, probiotic cleaning agents can be used freely, except in areas where sterility is required. Since probiotic cleaning is relatively new in healthcare, it should not, for caution, be used in facilities of hygiene class 3, such as operating rooms, treatment rooms for particularly infection-sensitive patients, and similar areas.

Regarding patient safety, probiotic cleaning is used without negative effects in facilities with sensitive patient groups, including third-degree burn patients, elderly patients with weakened immune systems, and pediatric emergency departments.

Currently, there are no known cases in the literature where probiotic cleaning agents have caused infections.

mikiGREEN® CARE

mikiGREEN® is a probiotic cleaning agent that contains 100,000 strains/ml of various types of naturally occurring microorganisms, including those from the genera Bacillus and Lactobacillus. The diversity of species ensures a broad metabolic base and high flexibility in adapting to different environments. To keep the microbial culture active, the product contains a nutrient solution with substances from the plant and mineral world.

In addition, it contains organic acids, non-ionic surfactants, and a natural fresh scent. The surfactants are so-called sugar surfactants, produced by the reaction of glucose (grape sugar) with plant oils to form alkylpolyglucosides. This type of surfactant is much gentler on the skin, eyes, and lungs than commonly used synthetic surfactants.

mikiGREEN® is delivered as a concentrate and is available in several variants, including an all-purpose cleaner and an anti-lime variant for wet areas. It can be used in spray bottles, for wet mopping, and in cleaning machines.

It is 100% biodegradable, environmentally friendly, and safe for humans, animals, and nature. mikiGREEN® is manufactured in Bavaria, Germany.



mikiGREEN® Produkte

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mikiGREEN® I Elsternweg 44 I D-85757 Karlsfeld I Germany

For inquiries and questions,
please contact: ulf.sparre@mzmp.eu