News Release
Kao Corporation

Kao
Kirei–Making Life Beautiful

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FOR IMMEDIATE RELEASE

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Communal Bacteria (Biofilm) that Adheres to Towel Fibers Discovered Formation of Microbial Flora Unique to Towels Confirmed

The Safety Science Research Laboratories and the Household Products Research Laboratories of Kao Corporation investigated towels used at home, and found that a community assembly of bacteria (biofilm) is formed on the ground warp part of the towel after half a year of use. It was also confirmed that the bacterial species that comprise the biofilm are a unique microbial flora*1 that are rarely present on the skin such as fingers but includes bacteria that located near the roots of plants. These bacteria do not easily come off even when washed, and it is presumed that they cause dullness in towels.

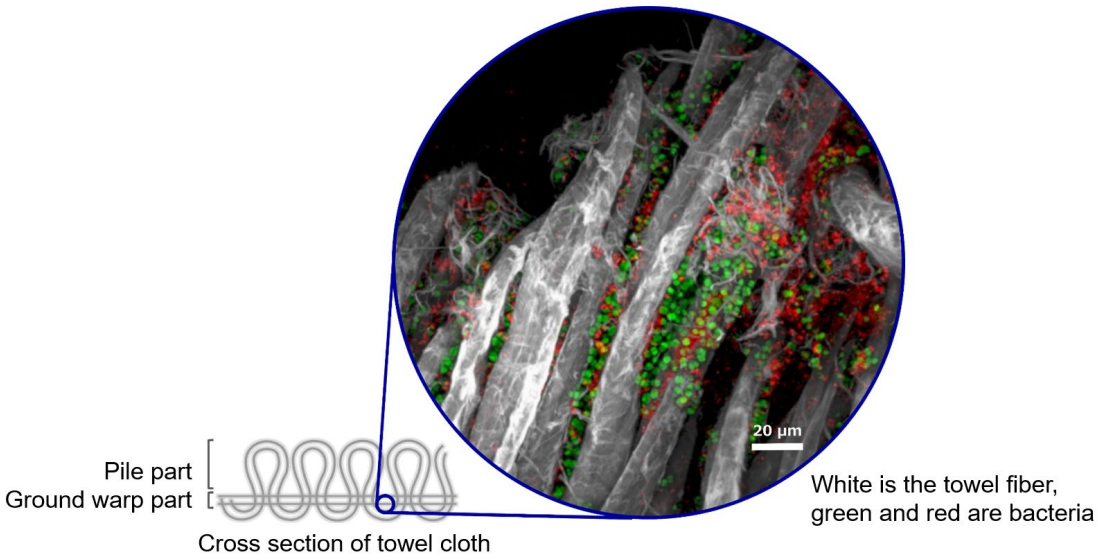

Fig. 1. Microscopic image of the structure of the towel and the place where the community of bacteria (biofilm) was observed

Part of this research was presented at the 16th Society of Genome Microbiology, Japan Annual Conference (March 2–4, 2022, Tokyo). The results of this research will be applied to the development of new clothing cleaning technology.

*1 An assemblage of all bacteria that present in a certain place

■ Background

One of the causes of odor and dullness in textile products around us is the increase of bacteria and bacterial metabolites. Issues caused by bacteria on textiles have been studied on some types of clothing, such as T-shirts.

Kao is continuing to conduct research on properly controlling bacteria that adhere to cloth through washing in order to prevent odors and dullness. Kao hypothesizes that if the materials, weaves and knitting methods of textile products are different, the types of bacteria that settle in, the way they attach, and the problems that arise will change. Research focused on towels used for hygiene activities such as hand and face washing, gargling and bathing.

The towel has a unique structure that is fluffy and thick. In everyday life, people are often aware of the odor and dullness of towels, but little research has been done on the bacteria that adhere to them. Therefore, Kao investigated how bacteria adheres to the surface of cloth and what kind of problems they cause.

■ New towels were used as usual for half a year

In this survey, researchers distributed new towels to 24 households and asked participants to use and wash them as usual, and investigated the changes every two months. The color of the towels became so dull that it was obvious at a glance (Fig. 2).

Fig. 2. Towels that have been used and washed repeatedly

It is known that when bacteria attach to a surface, they form concentrated community called biofilm, and in the process, they secrete substances such as polysaccharides, proteins and DNA outside the cells.

Therefore, researchers considered that bacteria had adhered to these towels and formed biofilm which caused dullness, so the amount of biofilm on the towels was investigated. As a result, in addition to the number of bacteria themselves, which make up biofilm, polysaccharides, proteins and DNA all increased over time.

■ Microscopic observation of towel fibers

The towel has a structure in which threads woven in a loop shape (pile part) are three-dimensionally overlapped with threads woven in a plane (ground warp part), and thanks to this pile part, we can enjoy its fluffiness. The fibers that make up the threads of the collected towels were observed in detail under a microscope to see how bacteria adhered to these towels and formed biofilms. Surprisingly, the bacteria were not found on the pile part where the bacteria were most likely to make contact with surfaces. However, when the root of the pile was squeezed and loosened from the ground warp part, it was clear just how many bacteria were densely packed among the fibers (Fig. 1). The number of the bacteria seemed to increase as the towel was used for two to six months (Fig. 3).

There are various possible reasons why the biofilm was formed in such a place, but one is that the

threads on the towel surface (pile part) are large and move easily, so the bacteria are frequently exposed to laundry detergent. This makes it difficult for bacteria to adhere there. It was thought that bacteria prefer places where threads do not move easily and remains wet, such as the ground warp part of towels.

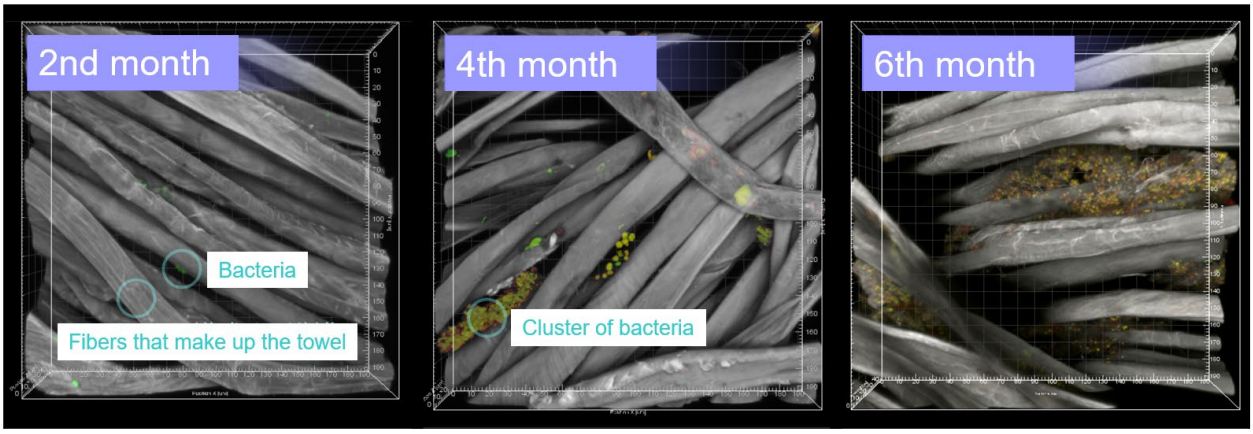

Fig. 3. Microscopic images of bacteria accumulating in the gaps among fibers over time

■ Identity of bacteria in biofilm on the towels

Kao further investigated what kind of bacteria were in the biofilm formed on the towels. When DNA of the bacteria on the towel was extracted and analyzed by a method (Meta-analysis of 16S rRNA) to reveal the bacterial species and their compositional ratio, bacteria of the genus Moraxella, which is often seen in clothes with a musty smell, was frequently found. It has been reported that many bacteria that are abundant on skin were detected in clothing such as T-shirts, but bacteria of the genus Staphylococcus that are abundant on skin were hardly found on the towels.

Interestingly, bacterial genera such as Brevundimonas and Aureimonas, which were rarely reported in the past on textiles, were frequently found on towels with a large amount of biofilm. Therefore, regarding the relationship between the proportion (abundance ratio) of the genus Aureimonas and the amount of polysaccharides in the biofilm, because the higher the abundance ratio of Aureimonas, the greater the amount of polysaccharides (Fig. 4, left), these bacteria were considered to comprise the biofilm. Furthermore, it was also confirmed that the higher the proportion of the genus Aureimonas, the higher the change in whiteness (relative dullness) compared to new towels (Fig. 4, right).

From these results, it is suggested that not only the bacteria transferred from human skin but also that only bacteria that could survive in the towel's unique structure and environment, where the threads are relatively immobile and water tends to remain on the towel, could grow. Bacteria of the genera Brevundimonas and Aureimonas, which belong to the group Alphaproteobacteria, are abundant on the roots of plants. These bacteria may adhere firmly to the towel fibers of plant-derived cotton material just as they attach to roots.

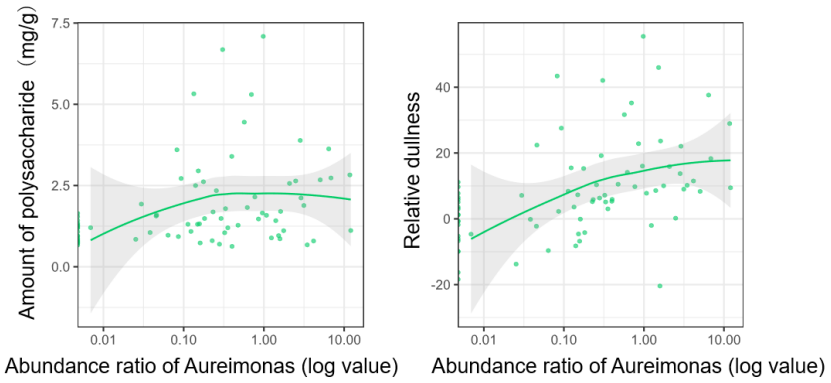

Fig. 4. Relationship between abundance ratio of Aureimonas, the amount polysaccharide (left) and relative dullness (right)

■ Conclusion

Using towels as an example, the kinds of bacteria that could adhere to the fluffy threads and form a biofilm were investigated. As a result, it was found that bacteria are densely packed in the gaps among the threads in the ground warp part of the towel. Also, the bacteria were considered not only transferred from the skin, but also that only bacteria that could survive in fibers with a towel-like structure could grow, which cause dullness.

In conclusion, it has become clear that even among textile products that are washed together in a washing machine, there are various bacteria and problems that adhere to them depending on their structure and usage. Going forward, Kao will continue to investigate the formation behavior of biofilms on various textile products and develop cleaning technologies that solve these problems.

About Kao

Kao creates high-value-added products that enrich the lives of consumers around the world. Through its portfolio of over 20 leading brands such as *Attack*, *Bioré*, *Goldwell*, *Jergens*, *John Frieda*, *Kanebo*, *Laurier*, *Merries*, and *Molton Brown*, Kao is part of the everyday lives of people in Asia, Oceania, North America, and Europe. Combined with its chemical division, which contributes to a wide range of industries, Kao generates about 1,420 billion yen in annual sales. Kao employs about 33,500 people worldwide and has 135 years of history in innovation. Please visit the Kao Group website for updated information.
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