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Sustainability in surface disinfection

Innovations in

- Formulation
- Wipe Material
- Primary Packaging

Whitepaper

Sustainability in surface disinfection:
Bacillol® Zero Tissues

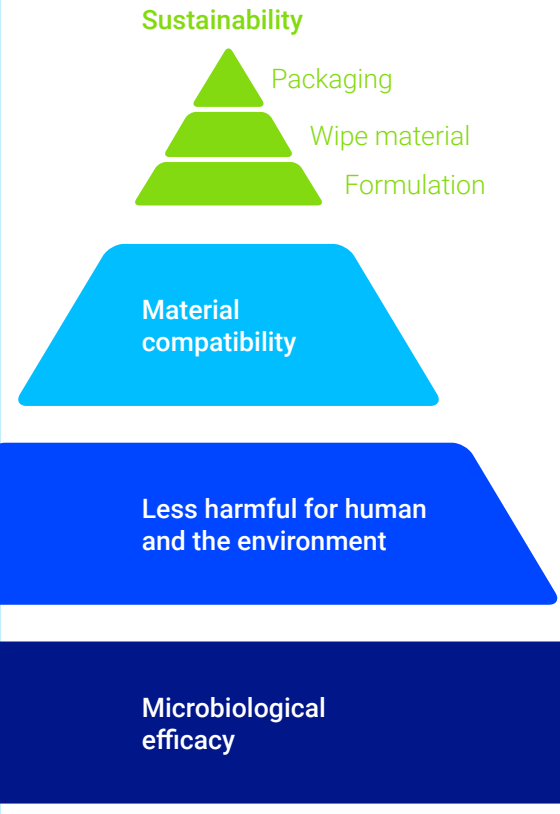
Contents

1 Disinfection and sustainability

Sustainability in the healthcare sector

Healthcare facilities face the challenge of becoming sustainable: The healthcare system is responsible for 4.4% of all CO_2 emissions worldwide and would therefore - if it were a country - be in fifth place among countries with the highest CO_2 emissions [1]. Direct emissions (**Scope 1**, e.g. vehicle fleet, fuel) and indirect emissions (**Scope 2**, e.g. electricity and gas) account for just under a third, but **Scope 3** emissions, which include goods, services, production and transport, make up the lion's share [1]. On average, a hospital generates 2.9 to 5.4 kg of total waste per patient per day [2], of which, according to another study, around 619 g is plastic waste, of which less than 5% is recycled [3].

These statistics emphasise the urgent need to reduce waste in the healthcare sector. On the one hand, there is potential in waste management, as improvements in waste separation and the recycling of non-infectious materials can close material cycles and fewer recyclable materials need to be incinerated. On the other hand, it is necessary to develop medical and disposable products that generate less waste and also protect the environment on other levels. At the same time, the products must not jeopardise the safety of staff and patients and their use must not require additional work for employees.



Ready-to-use surface disinfectants

One product group with room for improvement is surface disinfectants for professional users in the healthcare sector. Classified as biocidal and/or medical devices, these chemical formulations are used to inactivate pathogens on inanimate surfaces. Over the last 15 years, ready-to-use wipe systems, in which the disinfectant is applied to the surface using pre-soaked wipes, have become the standard for the daily routine disinfection of **patient-near surfaces**: The advantages lie in the ease of use, the prevention of dosing errors and avoidance of the handling of disinfectant concentrates, which require a number of measures to protect people and the environment. Ready-to-use products, on the other hand, are quickly to hand, save time and thus increase the willingness to disinfect - the hygiene compliance [4], which **improves patient safety** [5, 6]. However, the requirements for disinfectant wipes are constantly increasing (**Fig. 1**).

Figure 1:
Requirements for surface disinfectants with a focus on ready-to-use wipes.

Disinfection and sustainability

1 → Sustainable innovations in disinfection

First and foremost, disinfectants must be microbiologically effective. The active ingredients they contain are subject to strict regulations that focus on efficacy and safety: The focus is on **low risk to the user and patient** as well as extensive material compatibility. In contrast, there are no regulations on sustainability, which is why it has played a subordinate role in research and product development to date.

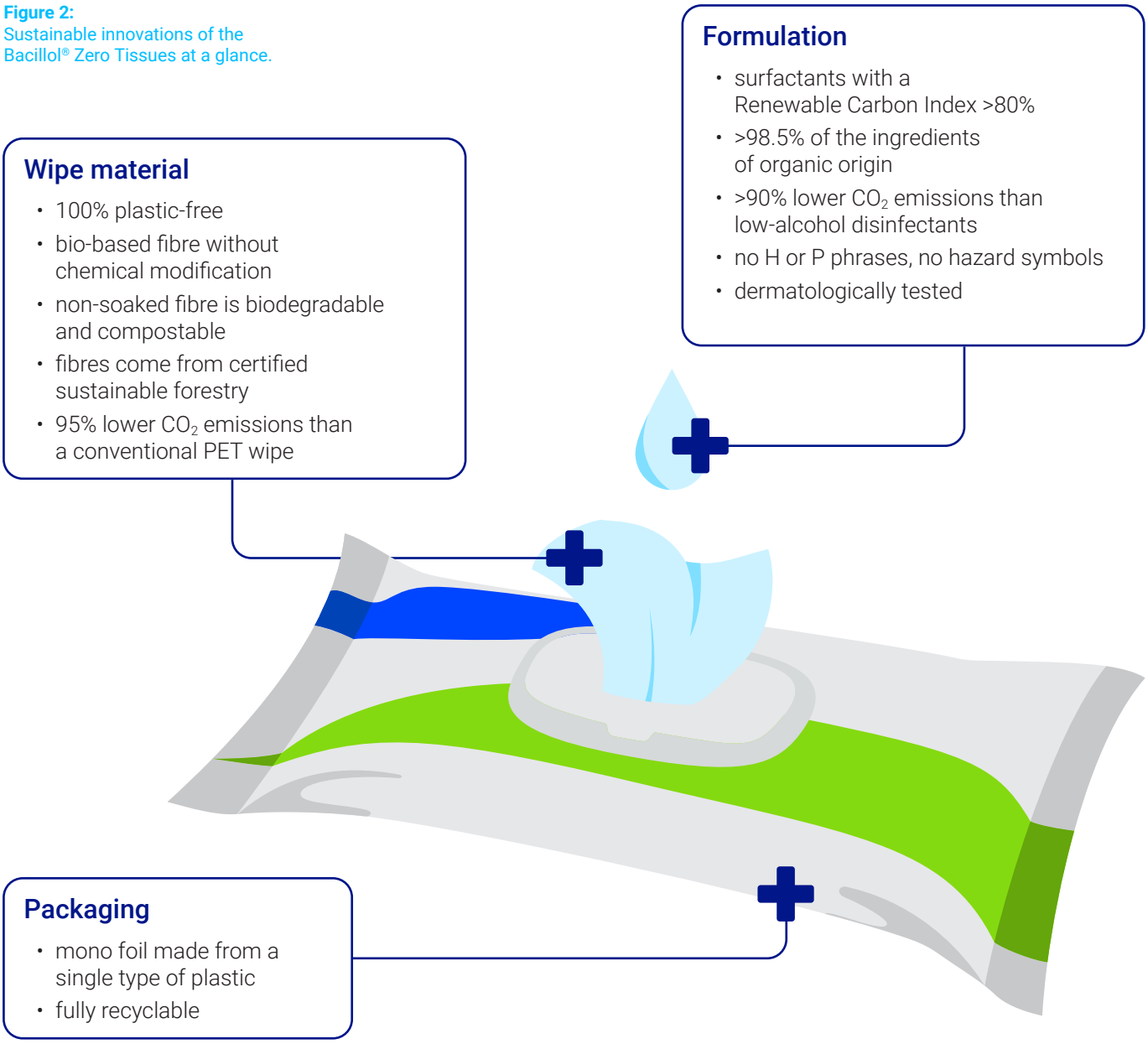
However, innovations for more sustainable disinfectants have also been neglected in recent decades because surface disinfectants are regulated by the Medical Device Regulation (MDR) and/or the Biocidal Products Regulation (BPR), which expressly prohibit trivialising advertisment [7]. As they are therefore not easy to advertise and there was no demand from users, manufacturers had little incentive to develop more sustainable products in the past. However, in order to achieve the sustainability goals and reduce the high CO_2 emissions of the healthcare sector, disinfectants must also be re-thought and re-designed **with sustainability in mind**.

From spring 2022 to spring 2023, around 817 million wipes for surface disinfection were sold to German hospitals. At an average weight of 2.2 g per wipe, this amounts to a total of 1,800 tonnes of plastic that was produced and ultimately incinerated, as potentially infectious hospital waste cannot yet be recycled. However, it is not only the wipe or the plastic packaging that must be considered from a sustainability perspective, but also the chemical formulation on which the surface disinfectant is based (**Fig. 1**).

2 At a glance
Bacillol® Zero Tissues

Bacillol® Zero Tissues were developed with the aim of fulfilling all the requirements mentioned above (**Fig. 1**), with a particular focus on sustainability. During the development process, all components of current ready-to-use wipes were critically scrutinised and subjected to **a sustainable transformation**, from the chemical formulation to the material of the wipes and the packaging (**Fig. 2**).

Figure 2:
Sustainable innovations of the Bacillol® Zero Tissues at a glance.



3 Formulation
How grapes protect from germs

The *organic acid complex*

The essential innovation in Bacillol® Zero Tissues is the new active ingredient system, the *organic acid complex*. This patented complex consists of two food-grade **organic fruit acids** that also occur in nature: sodium benzoate and tartaric acid. They work synergistically, penetrate the cell, and inactivate pathogens from the inside [8].

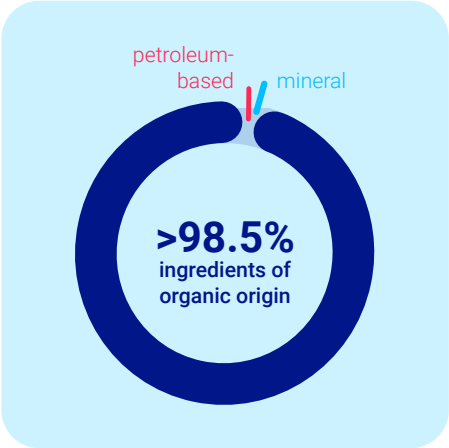


Figure 3:
Origin of the ingredients of the Bacillol® Zero Tissues.

More than 98.5% of organic origin

Another component of surface disinfectants are surfactants, which enable cleaning during wiping. They usually consist of long carbon chains. The carbon can either be of natural organic origin or petrochemical [9].The surfactants contained in Bacillol® Zero Tissues have a Renewable Carbon Index (RCI) of more than 80% in accordance with EN 17035 [9], meaning that they are largely **derived from natural sources**.

Overall, the formulation contains more than 98.5% ingredients of organic origin (**Fig. 3**). Only 10% CO_2 equivalents (CO_2e) are emitted during production compared to formulations in surface disinfectants with a low alcohol content (approx. 30% alcohol), which currently dominate the market in Central Europe [10].

Less harmful for human and the environment*

Bacillol® Zero Tissues are not classified as hazardous in accordance with the EU Chemicals Regulation on the classification, labelling, and packaging of chemicals (CLP Regulation) and therefore do not have any hazard symbols or safety instructions. They are also dermatologically tested. They can be used without gloves, provided infection protection and occupational safety permit this. The environment is also less at risk than with some conventionally used active ingredients, which have acute or even long-lasting toxicity, e.g. to aquatic organisms. In contrast, the active ingredients of Bacillol® Zero Tissues are biodegradable and **do not accumulate in the environment** [11, 12].

Its microbiological effectiveness is guaranteed: In accordance with European standards, the active ingredient complex is bactericidal (EN 13727, EN 16615), yeasticidal (EN 13624, EN 16615), and virucidal (EN 14476, EN 16615**) within two minutes.

Due to the broad spectrum of antimicrobial efficacy with reduced risk for users and patients, Bacillol® Zero Tissues are also suitable for use on patient-near surfaces, which are considered important for the **prevention of healthcare-associated infections** [13].

* according to the Simplified Authorisation of the BPR [7]

** modified 4-field test

Formulation
How grapes protect from germs

3

Material compatibility

Common ingredients in surface disinfection products are often not suitable for use on all surfaces in healthcare facilities, such as alcohols on acrylic glass. Incompatibility can lead to permanent damage of surfaces, which in turn makes these surfaces less easy to disinfect and can impair the function of medical devices [14, 15].

Bacillol® Zero Tissues have been tested for material compatibility with various plastics and plastic blends commonly used for medical devices. Bacillol® Zero Tissues are compatible with all 15 plastics and plastic blends tested (DIN EN ISO 22088) (**Fig. 4**) [16]. The very good material compatibility means that medical devices and surfaces in the vicinity of the patient can be disinfected without damaging the material. This **increases the durability** of medical devices and surfaces, and therefore their sustainability.

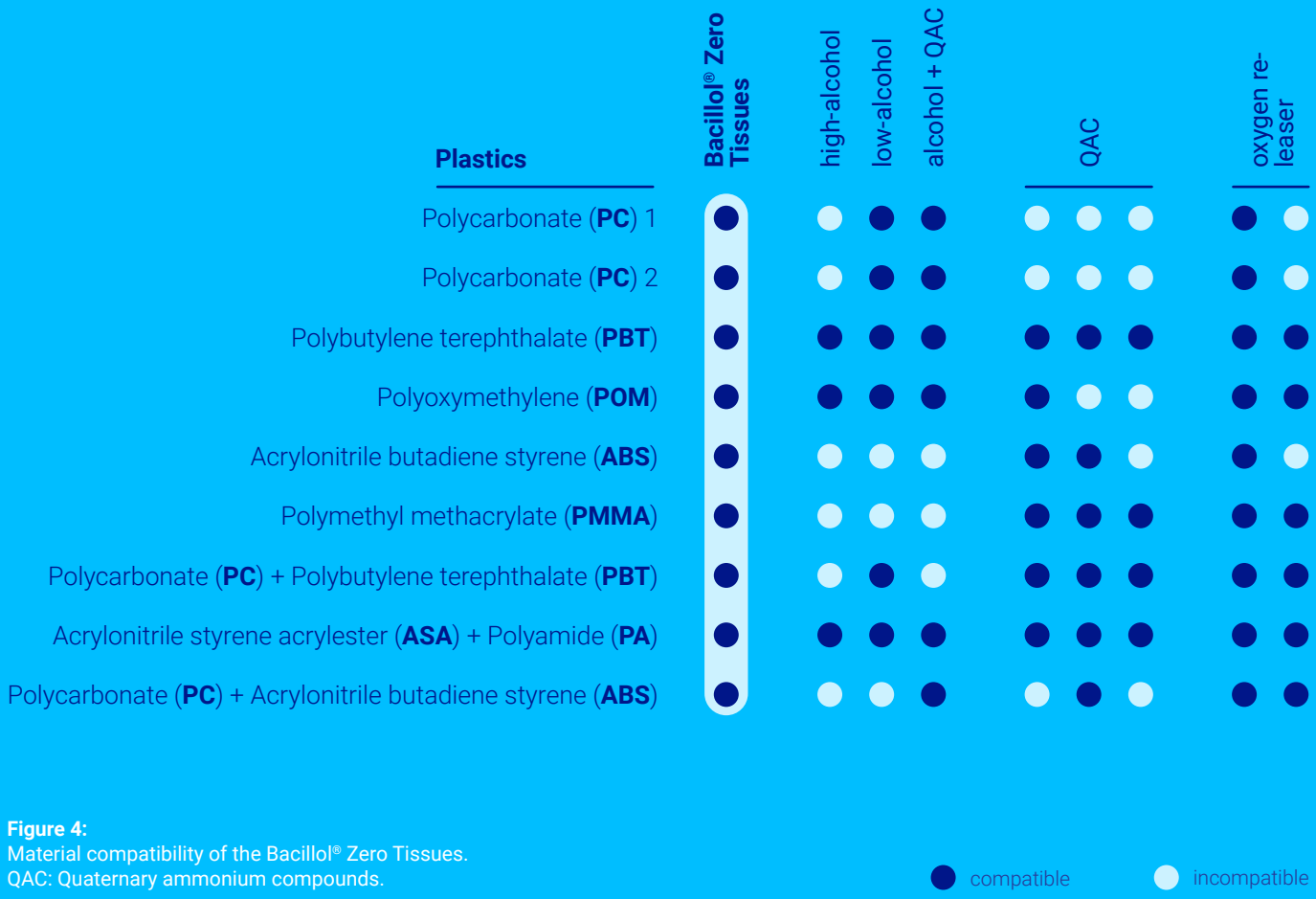


Figure 4:
Material compatibility of the Bacillol® Zero Tissues.
QAC: Quaternary ammonium compounds.

4

Wipe material:
Regenerating instead of synthesising

The wipes of Bacillol® Zero Tissues are more environmentally friendly than conventional surface disinfection wipes made from plastic fibres in several respects:

- They are made from **bio-based fibres** from the natural polymer cellulose, so-called regenerated fibres, and therefore do not fall under the European Single-Use Plastics Directive [17].
- The non-woven wipes are **100% plastic-free** and do not release any microplastics.
- Certain bio-based fibres are chemically modified, such as fibres based on cellulose acetate; they therefore fall under the European Single-Use Plastics Directive [17]. In addition, their biodegradability is no longer guaranteed due to the modifications. The fibres in the wipes of Bacillol® Zero Tissues, on the other hand, are unmodified.
- The non-soaked fibre is therefore not only biodegradable, but also industrially compostable in accordance with EN 13432.
- The cellulose comes from sustainable, PEFC-certified forestry. This means that CO_2 emissions are returned to the global CO_2 cycle during combustion.
- The total CO_2 footprint of a wipe is more than 95% lower than that of a standard PET wipe (**Fig. 5**) [10].

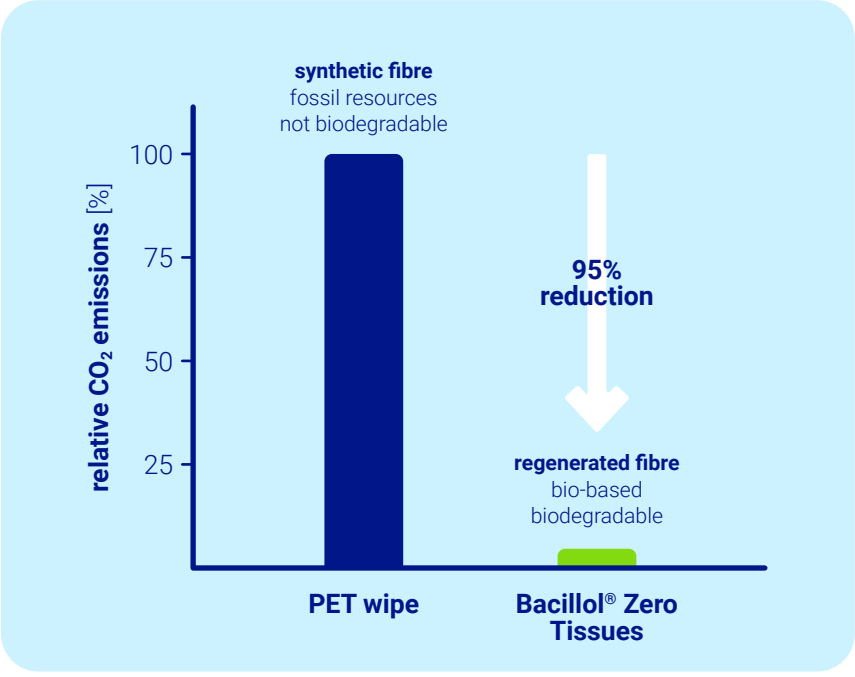
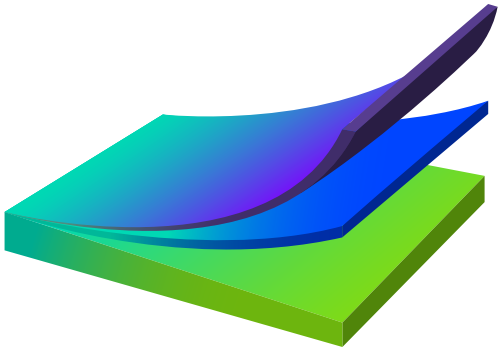


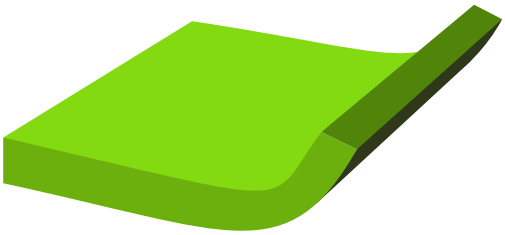
Figure 5:
Relative CO_2 emissions of conventional PET wipes and the wipes of Bacillol® Zero Tissues.

5 Primary packaging
Less is more



The current standard: composite foils

The packaging of ready-to-use wipes usually consists of plastic mixtures and duplex or triplex foils **(Fig. 6**). These composite foils made of several different plastics are resistant to chemicals so that they cannot be dissolved by the ingredients of the disinfectant. At the same time, they ensure that the disinfectant is protected from external influences such as sunlight. However, the different plastics cannot be separated from each other and therefore cannot be recycled [18]. They are therefore incinerated like residual waste.



Recyclable mono foil

As the formulation of Bacillol® Zero Tissues is **free from lipophilic, volatile solvents**, it was possible to dispense with the complex structure of the packaging. Instead, the packaging consists of a mono foil made exclusively of polypropylene (**Fig. 6**). This reduction means that the packaging is now fully recyclable [18].

Figure 6:
Composite foil made from different plastics (top) in comparison of mono foil made from a single type of plastic (bottom).

Development of the waste management

Currently, waste separation and recycling are rarely carried out in healthcare facilities; most of the waste is potentially contaminated and is therefore incinerated. However, hospitals are increasingly introducing comprehensive waste management - to reduce their environmental footprint, but also because incinerating waste is becoming increasingly expensive. Since the beginning of 2024, every tonne of waste that is incinerated has been subject to additional CO_2 pricing. As a result, there are now also financial incentives for recycling, provided the material is suitable and not contaminated. This applies to the packaging of Bacillol® Zero Tissues.

In the balance sheet
75% less emissions

Calculation of the CO_2 footprint

The carbon footprint is the calculated emission caused by a product. The entire life cycle of the product is taken into account: from the extraction of raw materials to production, storage, transportation, and use to final disposal or recycling. The value describes how much greenhouse gas is released in total and is often expressed in CO_2 equivalents (CO_2e). CO_2 serves as a reference gas into which the greenhouse effect of other gases is converted.

More than 80% less CO_2 emissions

By reducing emissions, the carbon footprint of Bacillol® Zero Tissues has been reduced by more than 75% compared to standard low-alcohol PET disinfectant wipes on the market (**Fig. 7**):

- **The formulation causes only 10% of the CO_2 emissions** of a low-alcohol disinfectant solution.
- **Bacillol® Zero Tissues also perform better in terms of waste during production:** for example, only around half as many litres of waste water are produced compared to the market standard, and correspondingly fewer CO_2 emissions are generated during processing [10].
- The production of Bacillol® Zero Tissues packaging releases the same amount of CO_2 as the packaging of other surface disinfectant products, but **the foil of Bacillol® Zero Tissues can be recycled.**
- **The tissue material causes 95% less CO_2 emissions.** It is also from sustainable forestry, so that the CO_2 emissions released during incineration are returned to the global CO_2 cycle.

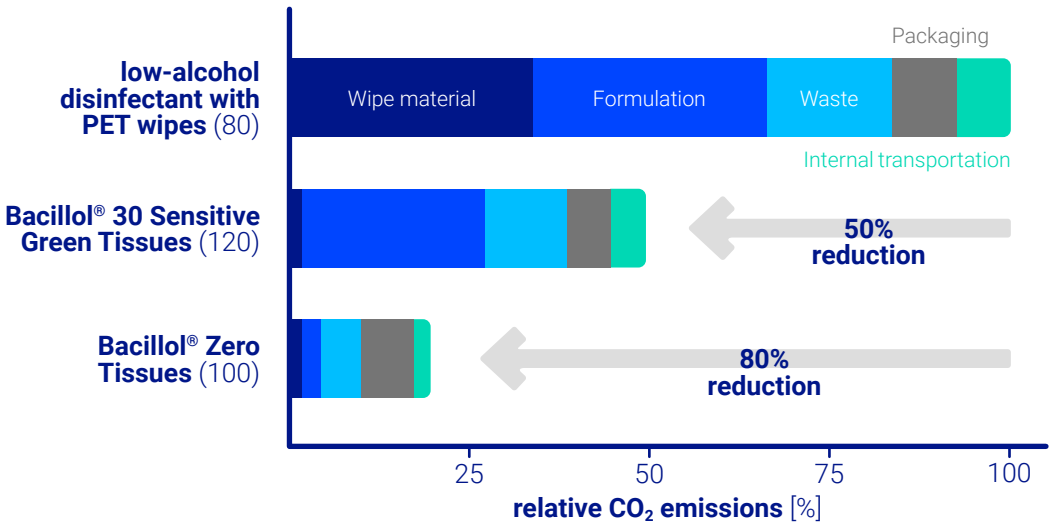


Figure 7: Comparison of CO_2 emissions during the production of low-alcohol disinfectant wipes and Bacillol® Zero Tissues. For better comparability, the figures refer to a single wipe of a flowpack. The total number of wipes per flowpack is indicated in brackets.

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