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Foldable UV-Sterilized Spoon: A Compact Self-Cleaning Solution for Hygienic Eating on the Go

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Abstract: The Foldable UV-Sterilized Spoon is an innovative product that integrates hygiene and convenience in one compact form. Designed for modern users who prioritize safety and sustainability, it combines a collapsible spoon with a UV sterilization mechanism encased in a lipstick-sized box. The device uses rechargeable power to activate a UV-C LED for efficient sterilization, ensuring bacteria-free utensils. The spoon is coated with an antimicrobial layer and folds neatly into the box, which opens only from the top for user safety. The study explores the need, feasibility, and real-world application of this product, with a focus on its design, sterilization performance, and user satisfaction, supported by relevant testing and research.

Keywords: *foldable spoon, UV sterilization, antimicrobial cutlery, compact hygiene, reusable utensil, self-cleaning spoon*

INTRODUCTION:

Cutlery is one of the most commonly used food-contact surfaces, yet it often receives the least hygiene attention in outdoor settings. In urban environments where people frequently dine outside, carry reusable utensils, or pack lunches, ensuring that these tools are germ-free becomes a challenge. Reusable spoons often get stored in unclean conditions after a single use, posing health risks. Moreover, existing cleaning methods require water, soap, and access to a wash area, making them inconvenient. This results in either people resorting to disposable spoons, which harm the environment, or carrying dirty utensils in bags or pockets. Addressing this challenge, we present the Foldable UV-Sterilized Spoon—a compact, hygienic solution that ensures germ-free use without external cleaning aids. The spoon can be folded and placed inside a UV sterilizer box that runs on a rechargeable battery. With a top-only opening design for safety and a durable antimicrobial coating, this solution is crafted for modern, health-conscious, and mobile lifestyles. It promotes reusable habits while maintaining hygiene standards, thus merging eco-friendliness with public health.

NEED OF THE STUDY:

The increasing concern over hygiene-related illnesses, particularly those arising from the use of unclean cutlery in public settings, highlights the urgent need for innovative personal hygiene solutions. With rising health awareness in the post-pandemic era, individuals are more conscious about the safety of the utensils they use daily, whether at school, work, travel, or outdoor locations. Traditional methods of ensuring clean spoons—such as rinsing in public sinks or carrying bulky cases—are neither reliable nor convenient. Disposable plastic spoons, although seen as a safer option, contribute significantly to environmental pollution and are being banned in many regions due to sustainability concerns. The current lack of compact, self-

sanitizing, and reusable spoon alternatives underlines a significant gap in both the hygiene and sustainability product markets.

This study addresses this gap by introducing a foldable, self-cleaning spoon that integrates UV-C sterilization in a compact, lipstick-sized box. The innovation allows users to carry and clean their spoon with minimal effort while ensuring over 98% bacterial elimination after every use. By utilizing food-safe materials and a matte antimicrobial finish, combined with UV-C LEDs that activate automatically, the product meets the demands for portability, hygiene, and ease of use in a single solution.

Furthermore, the application of such a product spans various sectors—personal use, corporate environments, student communities, healthcare professionals, travelers, and food delivery personnel. The increasing demand for germ-free personal items and government efforts to eliminate single-use plastics highlight the relevance and urgency of adopting reusable, hygienic alternatives. The product also holds the potential to reduce waste management burdens while supporting personal and environmental health initiatives.

Ultimately, this study offers a solution to a growing public hygiene challenge by presenting a device that enables safer eating habits through innovation. By aligning with sustainability goals and enhancing personal protection, this foldable UV-sterilized spoon contributes not only to daily convenience but also to long-term lifestyle change.

RESEARCH METHODOLOGY:

This section outlines the systematic methodology adopted for the design and development of the Foldable UV-Sterilized Spoon. The methodology integrates qualitative and quantitative research to assess the product's feasibility, performance, and user acceptance.

1.Literature Review:

An extensive review of prior studies on portable hygiene devices, UV-C sterilization in consumer products, and antimicrobial coatings in food utensils was conducted. Indian publications were prioritized to understand the contextual challenges and solutions relevant to the local demographic.

2.Design and Development:

Based on the literature review, the design requirements were finalized. The spoon was crafted using foldable, food-grade stainless steel with an antimicrobial matte finish. The sterilizer box was designed to be compact, top-opening only, and embedded with UV-C LEDs operating at 260–280 nm.

3.Prototyping:

The prototype combined electronics and mechanical design using a 3D-printed housing for the box. A microcontroller-based timer was included to regulate a 60-second sterilization cycle. Battery performance and safety interlock features were also implemented.

4.Testing:

Laboratory tests involved microbial load measurements before and after sterilization. Real-life testing was conducted with 20 users from different sectors, such as students, traveller's, and office goers. Observations were recorded for usability, portability, and sterilization efficiency.

5.Data Collection and Analysis:

Sterilization success rates, user satisfaction scores, and battery endurance were collected and statistically analysed using descriptive methods to validate the prototype's effectiveness and appeal.

RESULTS AND DISCUSSION:

The foldable UV-sterilized spoon demonstrated significant potential during both laboratory testing and user evaluations. In microbial lab testing, the sterilizer achieved a 98.7% reduction of common bacteria such as *E. coli* and *S. aureus* after a 60-second exposure. The integrated safety switch effectively prevented

UV activation when the lid was open. Battery testing revealed consistent operation across 15 full sterilization cycles per charge.

User trials indicated high acceptance. Most users rated the product positively for convenience, hygiene assurance, and portability. The matte finish was also appreciated for its grip and aesthetics. Feedback highlighted its suitability for everyday carry, especially in college and office environments.

Challenges encountered included minor heating issues after repeated sterilization cycles, which were addressed by adding a heat-dissipating lining inside the case. Users suggested the addition of a low-battery indicator and an optional keychain hook for easier access.

Overall, the results confirm that the device fulfils its intended purpose efficiently. The concept of integrating sterilization within the utensil's carry case was well received and marks a step toward making hygienic practices part of everyday personal accessories.

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