



Letter to Editor

Novel Antimicrobial Polyionene-Based Spray for Foot Odour: An Open-Label, Pre-Post Intervention Study

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Citation: Hua W, Tey HL (2024) Novel Antimicrobial Polyionene-Based Spray for Foot Odour: An Open-Label, Pre-Post Intervention Study. Clin Exp Dermatol Ther 9: 227. DOI: <https://doi.org/10.29011/2575-8268.100227>

Received Date: 18 August, 2024; **Accepted Date:** 22 August, 2024; **Published Date:** 26 August, 2024

Foot odour (bromodosis) is a distressing condition, both socially and medically, was found to be derived from isovaleric acid, which is produced when *Staphylococcus epidermidis*, a resident species of the normal cutaneous microbial flora, degrades leucine present in sweat. In addition, *Bacillus subtilis* was detected in the plantar skin of subjects with strong foot odour, and this species was shown to be closely associated with increased foot odour [1].

There appears to be a constant concern with regards to body hygiene and malodour, making the use of agents such as fragrant deodorants and antiperspirants one of the largest cosmetic sellers globally (estimated to be worth about **US\$ 74.55 billion in 2019**) [2]. One of the most important personal care products is deodorant which contain antimicrobial agents that prevent body odor.

Current active ingredients in deodorants, such as triclosan and benzalkonium chloride, are small molecules (<600Da) that microorganisms can develop resistance against after repeated long-term use and may penetrate the skin, causing irritation and sensitisation. To address such issues, polyionenes, which are large-molecular membrane-disrupting polymers that contain quaternary ammoniums and varying hydrophobic components, has been synthesized [3].

Polyquaternium-117 is a cationic amphiphilic polyionene biopolymer that enables killing the microbes through a unique functional mechanism. This polymer will first attach onto the cell membrane of the microbe through strong multivalent ionic interactions between the cationic charges in the polymer and anionic phosphate groups on the microbial membrane. Thereafter, the hydrophobic components in the polymer insert into the lipid domain of the microbial membrane, leading to membrane disruption, membrane lysis, and eventually microbial cell death. Due to the nature of multivalent interaction and physical membrane disruption, the risk of development of antimicrobial resistance is very low [4,5].

We formulated a spray solution containing Polyquaternium-117 0.5%w/v as an active antimicrobial ingredient, together with isopropyl alcohol which is synergistically antimicrobial (unpublished data) and allows evaporation of the spray solution. The aim of this study was to preliminarily evaluate the efficacy and safety of this Polyquaternium-117-containing hydroalcoholic solution in healthy individuals and individuals affected by bromodosis in a single-center, open-label, pre-post intervention study.

We randomly recruited 70 subjects (age 37.59 ± 10.24 ; 49 females). The patients were to use the foot odour spray for 3 weeks, once

or twice daily as tolerated, and then undergo a questionnaire evaluation.

Before using the product, 52 participants (74.29%) were troubled by foot odor, while after using the product, only 13 participants (18.57%) still experienced foot odor. The incidence of foot odor was significantly reduced after the product use ($P < 0.001$, McNemar test). The usage details of the product among the 52 participants who had foot odor before using the product are shown in Table 1.

Out of the 70 participants, 5 (7.14%) reported adverse reactions: 3 experienced dryness, 1 had cracked heels and peeling skin, and 1 reported itching without any lesions after one week of use and subsequently stopped using the product. We posit these being the side effects of the isopropyl alcohol.

Age, Mean (SD)	36.40 (9.01)
Gender, n (%)	
Male	17 (32.69)
Female	35 (67.31)
Foot Odour Condition, n(%)	
Occasionally	40 (76.92)
Often	10 (19.23)
Constantly	2 (3.85)
How much does foot odor bother you?	
Mildly	32 (61.54)
Moderately	9 (17.31)
Severely	11 (21.15)
How often do you use the spray?	
once a day	25 (48.08)
twice a day	27 (51.92)
How effective was the spray in reducing the odour?	
Very ineffective	0 (0)
Not very effective	9 (17.31)
Effective	41 (78.85)
Very effective	2 (3.85)
How satisfied are you with the overall quality of the spray?	
Very satisfied	3 (5.77)
Satisfied	41 (78.85)

Unsatisfied	8 (15.38)
Very unsatisfied	0 (0)
How likely would you be to recommend this product to others?	
Very likely	8 (15.38)
Likely	33 (63.46)
Not likely	11 (21.15)
Very unlikely	0 (0)

Table 1: Demographics, apply practices of the participants with foot odour and effects of treatment on the spray.

Interestingly, about three quarters of the randomly selected study population report and are troubled by foot odour, though most cases were relatively mild. This could be related to conducting the study in a tropical region like Singapore. More than 80% of participants found the spray to be effective and were satisfied with its results.

In conclusion, results from this study suggest that the 0.5% Polyquaternium-117 hydroalcoholic spray solution can be effective and safe in reducing foot odour.

Author Contributions

HLT and WH conducted the study, analyzed the data and wrote the manuscript.

Acknowledgments

The authors acknowledge the funding support of Trisafe Healthtech Pte Ltd. Hong Liang Tey is supported by the Clinician Scientist Award (CSAINV20nov-0003) from the National Medical Research Council of Singapore.

Funding Information

This study was supported by Trisafe Healthtech Pte Ltd.

Conflict Of Interest Statement

HLT formulated the spray solution. WH has no conflict of interest to disclose.

Ethics Statement

All procedures performed involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants.

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