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Research Article

Antimicrobial effect of protective badges against respiratory infections "case of virus buster®"

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Abstract

Background: Preventing respiratory infections has been a battle horse for scientists and the medical profession for years. The present study was conducted to verify the antimicrobial effect of the "Virus Buster®" badge, which is a device for protecting the respiratory tract against pathogenic germs.
Methodology: The effectiveness of this badge was determined by comparing the airborne microbial load in the field of action of the "Virus Buster®" badge with the conventional ambient environment.
Results: The results obtained after statistical analysis of Student's t test showed that there was no significant difference between the growth rate of germs on culture media exposed to the ambient air inside the Laboratory and in the courtyard of the Faculty of Science of the University, in the presence or absence of the badge. Therefore, this airway protection device does not create better conditions for the prevention of respiratory infections.
Conclusion: The results of the present study provide an opportunity to conduct further research to elucidate the presence and antimicrobial effect of chlorine dioxide in the badge virus buster.

Keywords: Badge, Virus Buster®, airborne microorganisms, respiratory infections.

1. Introduction

Respiratory tract infections include pathologies that lead to numerous consultations, both in hospitals and in private or traditional medicine, and they are at the crossroads of many specialties: pediatrics, pneumology, allergology, immunology, infectiology [1]. Infectious etiologies are extremely varied; among them, bacteria and viruses hold a prominent place, led by respiratory infections [2] and remain of concern especially those caused by SARS-CoV, novel influenza viruses that can cause human infection and disease newly emerging acute respiratory infections can cause large-scale outbreaks with high morbidity and mortality [3].

The annual incidence of lower respiratory infections is very high in both industrialized and developing countries [4]. According to a 2017 WHO study [5], nearly 4 million people die from acute respiratory infections, with 98% of these deaths due to lower respiratory tract infections, and as such is a major public health problem. To prevent the transmission of these diseases, some prophylactic approaches have been developed, including masks (nose plugs) and air purifiers such as chlorine dioxide badges [6] developed by "Kiyou jochugiku as part of the fight against the COVID-19 pandemic. This study was initiated with the aim of verifying the air purifying effect of the "Virus Buster®" badge creating conditions for the prevention of respiratory infections.

2. Materials and Methods

2.1 Material

Our study material consisted of two "Virus Buster®" badges, which were provided by the office of the Minister of Scientific Research of the Democratic Republic of Congo Fig-1.

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Fig. 1: Virus Buster® Badge

2.2 Methods

2.2.1 Preparation of the framework and setting up of the device

Two devices for the realization of the experiment were mounted, one in front of the Faculty of Sciences of the University of Kinshasa, and the other in the Laboratory of Microbiology applied to Biological and Natural Substances (LaMaRBN) of the same Faculty.

For each device, a badge was hung at a height of about 30 cm from the pavement or floor and four Petri dishes each containing a culture medium (Mac Conkey, Nutrient Agar, Endo Agar and Sabouraud caf) were placed within a radius of about 1 meter, above the level of the badges in order to respect the distance (±25cm) which would separate the badge wearer's chest and airway. Then, the film was removed from the top of the badge to let the chlorine dioxide escape, in front of the previously opened boxes and allow a diffusion of this gas Fig.-2.

Fig. 2: Installed device

2.2.2 Evaluation of the antimicrobial effect of the "Virus Buster®" badge

2.2.2.1 Isolation and enumeration of ambient microorganisms in the field of action of the badge

The film of the badge was removed 15 minutes later, time necessary for the chlorine dioxide to diffuse into the immediate environment, then remove the lids of the Petri dishes containing sterile culture media intended for the growth of coliforms and other enteric microorganisms, non-demanding Gram-negative bacilli, yeasts, molds and mesophilic germs.

Petri dishes containing the culture media were exposed to the field of action of "Virus Buster®" and airborne microorganisms for thirty minutes.

Negative controls were Petri dishes containing the same types of culture media opened outside the field of action of the "Virus Buster®" badges and were incubated in an incubator at temperatures of 30°C for fungi, 37°C for total germs and other non-demanding Gram-negative bacilli and 44°C for coliforms and other enteric microorganisms for 48 hours. These tests were repeated three times in succession.

2.2.2.2. Reading the results

The growth of microorganisms was noted by the development of colonies on the solid surface of the culture media. The count of these germs was done by manual, naked eye counting to determine the microbial load in terms of colony forming units (CFU). Like Larcher (2019), we assumed that each isolated germ gives rise to one colony or CFU [7].

2.2.2.3. Morphological description of the colonies of isolated germs

The morphological description was based on morphological characters visible to the naked eye. These exclusive characters provide information on the identity of isolated colonies. Among these characteristics, we considered the size, shape, contour, elevation, reflection and color that are sufficient and necessary information that can lead to the presumptive identification of microorganisms.

2.2.2.4. Statistical treatment of the obtained data

Student's paired data test was used, using R software version 4.0.2, to compare the growth rate of germs on culture media exposed to ambient air inside the Laboratory and in the courtyard of the University's Faculty of Science, in the presence or absence of the badge.

3. Results and Discussions

3.1 Growth and enumeration of microorganisms

The table below presents the size (N) of the microbial population for each test repeated consecutively three times on different culture media, as well as the Average Colony Forming Units (CFU) in the presence or not of "Virus Buster®".

Table 1: Size (N) of the microbial population

Culture medium	Test 1		Test 2		Test 3		Mean N (CFU) ± Standard deviation
	growth	Number (CFU)	growth	Number (CFU)	growth	Number (CFU)	
NA (interior) Badge	+	144	+	60	+	102	102±42
NA (interior)/ Witness	+	160	+	96	+	150	136±34,42
NA (exterior) Badge	+	58	+	184	+	124	122±63,02
GN(exterior)/Witness	+	47	+	172	+	116	111±62,61
MC (interior) Badge	+	4	+	2	+	4	4±1,15
MC(interior) Witness	+	5	-	0	+	2	3±2,51
MC (exterior)_Badge	+	2	-	0	+	1	1±1
MC(exterior) Witness	-	0	-	0	-	0	0±0
EA (interior) Badge	-	0	-	0	-	0	0±0
EA(interior)/Witness	+	1	-	0	-	0	1±0,57
EA (exterior) Badge	+	3	-	0	+	1	1±1,73
EA(exterior) /Witness	-	0	+	1	-	0	1±0,57
SAB(intérieur)_Badge	+	13	+	14	+	13	13±0,57
SAB(interior)/Witness	+	12	+	16	+	13	14±2,08
SAB (exterior) Badge	+	14	+	12	+	15	14±1,52
SAB(exterior)/Witness	+	16	+	12	+	13	14±2,08

Legend :

NA: Nutrient agar; MC: Mac Conkey; EA: Endo Agar; SAB: Sabouraud
+: presence of microbial growth
- : lack of microbial growth

It can be seen from this table that the number of colony-forming units (CFU) decreases from an average of 136±34.42 to 102±42 CFU for mesophiles and from 14±2.08 to 1±0.57 CFU for fungi respectively.

Applying the Student's t test on the comparison between the size of the microbial populations, in the presence or not of the badge and inside the laboratory or outside, shows that the purifying effect of the badge is not significantly different.

Indeed, inside, two means from the same group of culture media with and without badge do not show that the two treatments are different, with: t = - 0.98614, p-value = 0.3968 >>> 0.05. Outside, the test informs that there is no significant difference, with t = 1.2699, p-value = 0.2937 >>> 0.05.

The microbial growth rates of these two environments, would be explained by the fact that abiotic factors such as pH, humidity, conductivity, insolation or available organic compounds, can maintain, enhance or limit the growth of microorganisms in their environment, as explained by Morissette (2020) [8]. These two environments, in this case the open air of the courtyard and the interior of the laboratory, do not have the same physical and chemical conditions, which would justify the difference between the population sizes.

Our results contradict those performed by Veldier (2015), who believes that the bacterial load should be lower inside the laboratory than outside for enumeration and similar profiles when the indoor environment is healthy [9]. This is proof that these badges are ineffective in purifying the air because of the power of chlorine dioxide. Therefore, the "Virus Buster®" has no influence on microorganisms inside and outside the laboratory that are within its range of action.

3.2 Morphological description of the colonies

The table below shows the macroscopic description of the colonies with or without the Virus Buster Badge.

It appears from this picture that the air is not healthy, it is loaded by a complexity of microbial strains.

The identification of bacterial strains based on macroscopic characteristics is a presumptive test. When reading the results in nutrient agar, the appearance of small colonies, yellow or whitish in color, regular or irregular in shape, with a flat, with an opaque sheen; is an indication that the test is positive, thus informing about the presence of total germs [10].

In Mac Conkey's medium, the appearance of whitish colonies with a smooth domed surface is an indication of a positive test; therefore, it is indicative of the presence of non-demanding Gram-negative Bacilli [11]. In the Endo-Agar medium, the appearance of small pink, translucent sheen colonies is an indication of a positive test; thus indicating the presence of coliforms [12]. The isolation of yeasts in the medium of sabouraud culture is positive if there is the appearance of colonies of small size and white, black or orange coloration [10]. These results are evidence of the inefficiency of this badge in air purification.

Table 2: Macroscopic description of the colonies

Culture media	Morphological elements of description of the colonies					
	Size	**Color**	**Contour**	**Elevation/ Surface**	**Reflection**	**Microbial groups**
NA (interior) Badge	Small, medium and large	White and yellow	Irregular and regular	Curved	Opaque	Total germs
NA (interior)/Witness	Medium and large	Whitish and yellowish	Irregular and regular	Curved and smooth	Opaque	
NA (exterior) Badge	Small and medium	Whitish	Irregular and regular	Plate	Opaque	
NA(exterior)/Witness	Medium and large	Whitish	Irregular and regular	Curved and smooth	Opaque	
MC (interior)_Badge	Small and medium	Colorless and whitish	Irregular and regular	Curved	Opaque	Non-demanding gram-negative bacilli
MC(interior) Witness	Small and medium	Colorless and whitish	Irregular and regular	Curved	Opaque	
MC (exterior)_Badge	Small	Blanche	regular	Curved	Opaque	
MC(exterior) Witness	-	-	-	-	-	
EA (interior)_Badge	-	-	-	-	-	Coliforms and other enteric microorganisms
EA (interior) /Witness	Small	Pink	Regular	Curved	Translucent	
EA (exterior)Badge	Small	Pink	Regular	Curved	Translucent	
EA (exterior) /Témoin	Medium	Pink	Regular	Curved	Translucent	
SAB(interior)Badge	Small and medium	Yellow and white	Irregular	Curved	Opaque	Yeasts and molds
SAB(interior)/ Witness	Medium	Yellowish and whitish	Irregular	Curved and smooth	Opaque	
SAB (exterior)_Badge	Small and medium	White, black, orange	Irregular	Curved	Opaque	
SAB (exterior) /Witness	Small and medium	whitish, yellowish, orange	Irregular and regular	Curved	Opaque	

Conclusion

The objective of this study was to determine the antimicrobial effect of the "Virus Buster®" badge on a few airborne microorganisms whose detection would indicate the presence of viruses, particularly the one responsible for COVID-19.

The study found that:

- After incubation, microbial growths were observed on different culture media, providing information on the presence of total germs, non-demanding Gram-negative bacilli, coliforms and other enteric microorganisms as well as yeasts and molds.
- The application of the Student's t test allowed us to compare the growth in the two groups of boxes, i.e. the control boxes and the boxes in the field of action of the badge, and to conclude that the "Virus Buster® " badge does not work on the microorganisms in the air, as the difference was not significant.

These results lead us to conclude that this virus buster badge is not adapted to viral pathogens.

Thus, we suggest that further research be conducted in the future, to remove ambiguities around the presence and antimicrobial power of chlorine dioxide in the "Virus Buster®" badge, to find unanimity on its effectiveness and furthermore its use throughout the world.

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