Design and Analysis of a Face Mask Alternative

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Abstract: Due to the recent pandemic that plagued the country, face mask disposal has gained considerable attention. If something similar were to happen again, the creation of an alternative to the medically approved surgical masks is crucial to minimize disease spread induced by improper face mask disposal. This study aims to analyze and determine the proposed output's effectiveness compared to conventional face masks. The materials for the trilayer output were nylon, paper towel, and cotton. The produced output and the control sample, the standard cloth mask, were sent to a lab for water resistance and absorbency tests. The test results revealed that neither the produced output nor the cloth mask could meet the recommended standards of a good face mask. As such, this research concluded that the production of an alternative face mask using the materials stated above in a manner identical to that of this study is ill-advisable. Additionally, the study affirmed that the standard cloth masks are not suitable as an efficient alternative to surgical masks. Overall, the paper intends to contribute to solving two of the United Nations' Sustainable Development Goals (SDG), which are (3) Good and Health Well-being and (12) Responsible Consumption and Production.

Key Words: face mask; alternative; resistance; absorbency; substitute

1. INTRODUCTION

Given the rapid spread of COVID-19 cases globally, the community's active population must use efficient face masks to mitigate virus transmissions. In a study conducted by Cheng (2020), countries with high compliance with face mask usage, such as Hong Kong (96.6%), have lower cases within the first 100 days of the virus exposure. From this, it can be concluded that community-wide mask-wearing has an inverse relationship with the number of transmissions.

As face masks have been proven to be an effective measure in preventing transmissions, Wu (2020) adds that the usage of face masks has become the global norm. With this in mind, billions of face masks have been produced and used yearly by various countries. Taiwan has consumed 1.3 billion surgical masks in one year. Sangkham (2020) also cites that each person in the general population used one face mask each day. On that note, improper disposal of infectious wastes, such as used face masks, may negatively impact both health and environment-related aspects.

To combat this problem, identifying sustainable and easily accessible materials for face mask alternatives is of great significance to the community. Thus, the researchers aim to create a better community face mask alternative in place of cloth masks by having it tested by laboratory professionals. Moreover, the study intends to assess, analyze, and determine the produced output's effectiveness compared to conventional face masks.

The materials for the output were nylon fabric, paper towels, and cotton. These materials were utilized based on determined criteria and accessibility in the perspective of an ordinary Filipino. In this manner, the researchers conducted tests to examine their efficacy in resisting water, preventing the entry of bacteria, and exhibiting comfortability.

2. REVIEW OF RELATED LITERATURE

The production of a community mask alternative with comparable effectiveness calls for being equipped with prior knowledge on related studies. Consequently, the researchers explored trusted sources to gain useful supporting information on the topic.

In his study, Cheng (2020) proved that community-wide mask-wearing has an inverse relationship with the number of transmissions. Countries with high compliance with face mask usage have significantly lower cases than those with low compliance. In this manner, the number of COVID-19 cases can be mitigated (Guan, 2020).

Unfortunately, a multitude of studies deals with existing face mask alternatives and their efficiency. Still, only a few were able to tackle the actual materials used for different types of masks. It is crucial that we further investigate the effectiveness of such materials. Likewise, understanding the

scientific properties behind the materials of existing face masks shall lead the researchers to identify critical points for alternative face mask production. Apart from this, studies related to suggested face mask homemade alternatives were considered. This is crucial as Khazan (2020) claims that people's daily activities will include face masks as necessities for a long time due to the pandemic.

Lastly, elaborating different processes of contamination measurement through valid sources led to helpful knowledge to create a scientifically accurate and acceptable experimental design to test the researchers' output.

As for the materials to be tested, common household materials that observe excellent filtration efficacy, particularly coffee filters and vacuum cleaner bags, were selected. Moreover, a study conducted by Davies (2013) suggests using breathable materials such as cotton and silk.

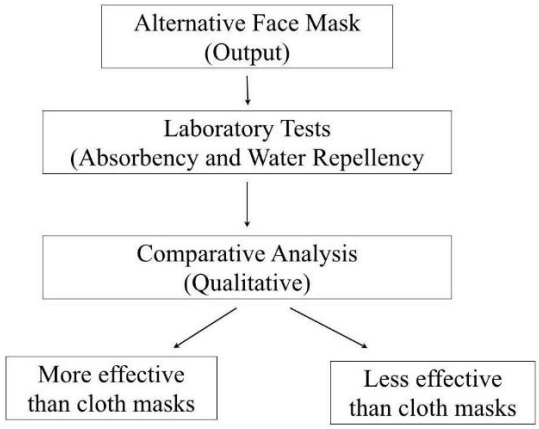
In the context of nylon fabric, Godoy (2020) claims that research suggests that adding an outer layer of nylon fabric to a homemade cloth face mask can increase its filtration efficiency. Accordingly, layers can potentially make the pre-made face mask comparatively similar to surgical masks.

According to Mayo Clinic (2019), cotton-made cloth masks are intended to trap droplets released from the wearer's mouth while observing superiority in terms of comfortability. In this manner, these masks can reduce the spread of external agents and viruses without compromising the wearer's comfort. Moreover, cloth face coverings are easily accessible by the community. These masks can also be easily rewashed and reused.

On the other hand, a single sheet of paper towels shows an unpromising 23% 0.03 micron particle blockage after a test by Robertson (2020), which adds 10% for an additional layer. However, Parker-Pope (2020) from The New York Times asserted that inserting a paper towel in the middle of two fabrics can make the mask more efficient and effective.

3. METHODOLOGY

In this study, data was collected through laboratory testing protocols. A prototype of the proposed output and a standard commercial cotton mask were sent to Intertek Laboratories for experimentation. Licensed laboratory professionals conducted the tests to determine how efficient each face mask performs, given the criteria.



3.1 Absorbency

The data gathered for the face masks' performance in absorbency was obtained through an Absorbency Test (AATCC 79). As stated by the American Association of Textile Chemists and Colorists (2018), this test method applies to any textile fabric as it determines its water absorbency. Therefore, it is suitable for measuring and comparing the two face masks' absorbency to gauge how they minimize skin moisture and facilitate sweat evaporation.

In this test, a drop of water was allowed to fall from a fixed height onto the fabrics' surface. Moreover, the time taken for the water drop to disappear and evaporate was measured and recorded as wetting time.

3.2 Water Resistance

The data gathered for the face masks' performance regarding water resistance was obtained through a Water Repellency Test (AATCC 22), also known as Spray Test. As stated by the American Association of Textile Chemists and Colorists (2017), this test applies to any textile fabric, as it measures its overall resistance to wetting by water. Therefore, it is suitable for measuring and comparing the water-repellent efficacy of the two face masks.

In this test, water was sprayed against the fabric surface under controlled conditions. This, in turn, produced a wetted pattern whose size varies based on the fabrics' relative repellency. Upon doing so, the wetted pattern was compared with pictures on a standard chart for further evaluation.

4. DATA AND RESULTS

Item Description	: Two (2) submitted mask marked as: (A) woven in white with green embroidery (outer side) and white pique (inner side) with 6 white panels (B) knitted in black with red print (outer side), white (inner side) with 3 white panels
Date Received/Date Test Started	: 17 November 2020
Fiber Content	: -
Color	: (A)White, (B)Black
Order No	: -
Article No	: -
Style No	: -

Based on the results shown above, both the experimental group (A) and the control group (B) failed to meet the standard in terms of water repellency. As the required remark is 70, which involves a partial wetting of the specimen face beyond the spray points, both groups (A and B) had 0 remarks due to their complete wetting upon testing. In the said experiment, three trials were conducted on both A and B. However, the results remained constant at 0. This means that the percent error of both samples is at 100%.

Moreover, the results show that the produced output (A) did not have water resistance levels more than or equal to standard cloth masks.

	(A)	(B)
Water Repellency	F**	F**
Absorbency Test	F**	F**

Note :
P = Passed the Commercially Acceptable Requirement
F*= Failed the Commercially Acceptable Requirement
= No Specified Requirement
* = No Submitted Information
M1 = Meet the Submitted Requirement
F1 = Below the Submitted Requirement
M = Meet Buyer's Requirement
F = Below Buyer's Requirement

1. Water Repellency
AATCC TM22-2017e

		(A) Outer Side	(B) Outer Side	Requirement
Rating	Trial 1	0	0	70
	Trial 2	0	0	70
	Trial 3	0	0	70

REMARK:
Tested on Panels

Legend:
100 = No sticking or wetting of the specimen face
90 = Slight random sticking or wetting of the specimen face
80 = Wetting of specimen face at spray points
70 = Partial wetting of the specimen face beyond the spray points
50 = Complete wetting of the entire specimen face beyond the spray points
0 = Complete wetting of the entire face of the specimen

The results acquired from the laboratory in the context of absorbency show unsatisfactory results. The standard for water absorbency was not met; additionally, the control test results were shown to be much closer to the standard than the produced output. The produced output falls short of both the control group or the generic cloth mask and the recommended standards in terms of water absorption.

To expound better, the water absorbency in this test was measured in terms of time, wherein the amount of time (in seconds) it takes for the fabric to absorb a particular volume of water was measured. The time it took for the cloth mask and the produced output to absorb water was eight seconds and more than 60 seconds, respectively. This means given the required time is five seconds, the control had a percent error of 60%. Meanwhile, the produced output had a minimum percent error of approximately 1100%.

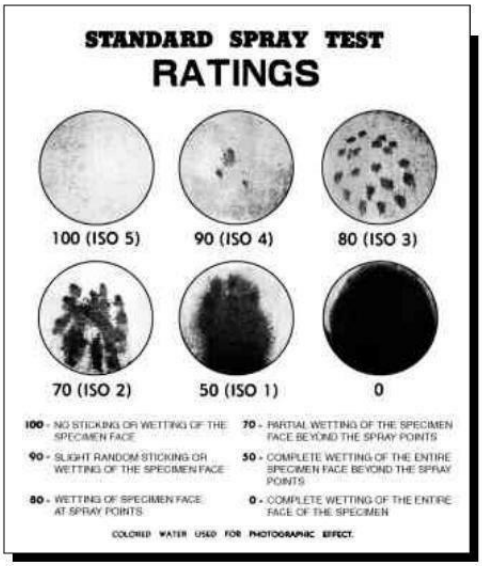


Fig. 1—Spray test rating chart.

2. Absorbency Test
AATCC TM79-2010e2(2018)e

	(A) Inner Side	(B) Outer Side	Requirement
	60 + s	8 s	≤5 s

REMARK:
s= seconds
Tested on Panels

5. CONCLUSIONS AND RECOMMENDATIONS

The study has concluded that the produced output is, in fact, less efficient than the standard cloth mask as a whole. The produced output falls short of the standards put together by the World Health Organization (WHO) and the properties of the cloth mask found in markets. As such, the materials used in producing the output—the nylon, the tissue paper, and the cotton—are ill-advised to be used, or at least to be used in the same manner as that in the study to produce an effective alternative face mask.

Given that the output could not be tested with certain criteria, such as filtration efficiency, flammability, and air permeability, which is crucial for a face mask, future researchers must consider this. It is necessary as these specific criteria are firm fundamentals for the effectiveness of a face mask. Additionally, it is also advisable for the manner of testing to be conducted by future studies to be more systematic and reliable than the method done in this study. A more reliable way of conducting the research would have been to test multiple samples of varying materials one by one and then produce an output, which would also be tested based on the results.

Moreover, citizens must be advised that commercially available cloth masks also performed poorly in the test. In conclusion, surgical masks are still the best option.

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