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SCIENTIFIC APPROACH IN THE MANUFACTURE OF CLOTH BARRIER

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ABSTRACT

The 2019 pandemic is fueling benefits and inconveniences around the world. This scourge has subjected humans to wearing masks to curb the spread of the virus. The mask remains one of the effective means that has slowed down the wreak effect. Faced with the concern of the production of local masks on the eve of the shortage of medical masks, one solution is the regulation of the production sector through manufacturing control. No studies have been conducted on the effectiveness of locally manufactured fabric masks. Devices for testing for respirable fine particles are very expensive. The objective of our study is to present the design and manufacture of the breathability and filtration test bench for local masks. To analyze and test the locally manufactured masks, they are listed on the market in the city, visually inspected, tested and controlled by means of the bench designed and manufactured. The results of the trials showed significant satisfaction with the effectiveness of the pleated masks.

Keywords: cloth masks, efficacy tests, test bench, scientific input.

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INTRODUCTION

Events follow one another but are not alike in the world making a story. Thus, the severe pandemic of 2019 is an episode on the world stage. This pandemic, which according to the World Health Organization, has claimed nearly thousands of lives. It has spared no country in any continent. It is caused by the coronavirus disease 2019 called COVID-19. A disease that has caused many deaths. In the face of this scourge, protection techniques are urgently needed to curb transmission. But still, the multiplicity of variants has marginalized scientists despite their efforts based on barrier means. This barrier means containment, the wearing of barrier masks, and the use of hydroalcoholic gel for hand washing.

Given the ravages of the virus, research is being done very quickly to stem this evil. Several avenues are proposed. Hand washing with hydroalcoholic gel and wearing masks have been retained. The latter seems and have considerably reduced the rate of contamination, the number of deaths. Masks in all forms are solicited. FFP2 masks, and surgical masks, even if they are not appropriate, are sought after because of the rate of transmission of the virus [1]. Faced with the increased need for protective masks, activities have developed in the manufacture of all kinds of loincloth masks. The composition, quality and effectiveness of these masks are to be checked.

Cloth masks have been used in healthcare and community settings to protect the wearer from infection [2]. The filtration efficiency of cloth masks is generally lower than that of medical masks and respirators. Cloth masks are known to provide some protection if properly designed and used. The effectiveness of wearing masks comes down to face coverage. It comes down to understanding the variation of viruses with these complications explains the fact the person's health should be taken seriously. Respiratory protective devices and these accessories can support or save lives, but they are not general solutions for everyone. Aware of the needs of the population, the freedom to make masks for the population to stem the evil is precarious.

Studies have been done on the effectiveness of respirators but no studies have been done on the type or effectiveness of tissue masks. Among the masks made, the pleated mask is the one that hides the face well. He is the one on which the study will focus. It must be flexible to the wearer but with fairly high filtration. The value of inspired air pressure (O_2) is of the order of 160 mmHg or 160 x $1.33.10^{-3}$ bar and that of exhaled air (CO_2) is of the order of 27 mmHg or 27 x $1.33.10^{-3}$ bar [3]. All these values are lower than the value of atmospheric pressure but still inspiration is possible thanks to the depression created by a vacuum in the rib cage and lungs.

In order to regulate the production or manufacture of such tissue masks, confirmatory testing and control remain necessary. The objective of the study is to present the scientific contribution through the design and realization of a test bench of respiratory efficiency and particle filtration to determine the values sought for a barrier mask.

MATERIALS AND METHODS

Our materials are the cloth barrier mask and a control bench that we have designed.

The material studied is the barrier mask made locally by sewing craftsmen. The barrier mask is a face piece covering the mouth, nose and chin equipped with a set of bridles [1]. Barrier masks are part of the objects used to hide part of the face. There are of several types of masks collected, bought, or taken in the city from vendors. With the pandemic and the need to use masks as barrier measures, several models of masks are deployed for public utility following the shortage and soaring price of masks. The masks are made with different fabrics with varying thicknesses. They are composed of envelope fabric (outer tissue) and one or more internal tissues of the mask. The

fabrics do not have the same flexibility. Porosity varies from one fabric to another. The internal tissue acts as a filter. Figure-1 shows the types of masks listed in the city.

(a)

(b)

Figure-1. Masks listed a. Pleated masks; b. Duck beak masks.

The second material is the tissue mask test and control bench shown in Figure-2. It is composed of a 50L T856 PRODIF coaxial compressor, a sprayer, connection pipes, a chamber, and talc. The compressor will store air in the cylinder up to a pressure of 12 bar. By means of a connecting pipe, the air is blown onto a lit candle to test breathability. On the other hand, for the filtration test, the air, through the connection, passes into the sprayer chamber where the talc is located. The nozzle of the sprayer communicates with a filter chamber, carrying the mask having a lid. The filtration test consists of checking the deposit of talc particles that have passed through the mask to settle in the lid.

The method adopted is to inspect the mask, to validate the pressure of the test that will be used to test the masks. The visual inspection is done to know the composition of the mask. The validation of the bench is done by relying on a standard pleated mask purchased at the pharmacy. To do this, at a constant pressure of 2 bar, air is blown through the mask.

Five masks are taken from a batch distributed as follows: 1 mask for the inspection test, two (02) for the breathability test (candle flame test) and two (02) for filtration. A batch of masks is a group of ten masks of the same size, different color or not, made of the same cloth. Ten (10) lots were tested.

Figure-2. Test and control bench.

To test the effectiveness of breathing, the masks are subjected to the flame test of a lit candle. The air is sent three times through the mask of which a lit candle is placed behind the mask. The candle does not go out. The air pressure is blown through the mask onto the lit candle and placed 5 cm in the direction of propagation of the blown air. The flame of the candle does not go out. This pressure is considered as the reference pressure with the control mask purchased at the pharmacy (see Figure-2) 3(a).

(a) (b)

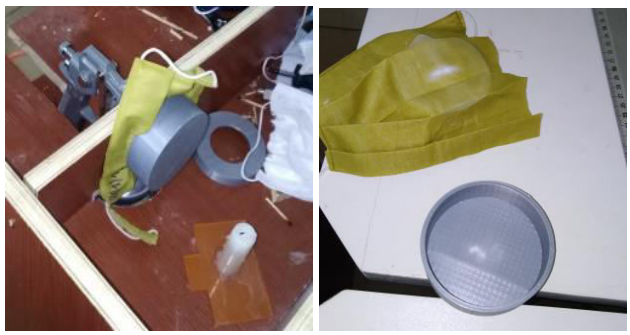
Figure-3. Mask candle flame test a. Validation with the surgical mask; b. Local mask testing.

The mask filtration exercise is done with talcum powder sprayed under pressure through the mask in a lid. The effectiveness of retained particles is attested when talc is sprayed at a given pressure through the mask. At a pressure of 2 bar on the surgical mask, the talcum powder is sprayed and observed in the lid. No particles are visible in the lid. This is called calibration. Figure-4 shows the pressure surgical mask test taken as a reference.

(a) (b)

Figure-4. Mask filtration test a. Validation with surgical mask; b. Finding of absence of particle deposition.

Two (02) masks from each sample will undergo this talc spraying exercise to observe the rate or quantity of talcs deposited. Talc is sprayed three times on the sample. The particles are retained by the fabrics of masks. In the lid closing the empty chamber, the deposition of particles is sought. Two (02) masks from each sample will undergo this talc spraying exercise to observe the rate or quantity of talcs deposited. Talc is sprayed three times on the sample. The particles are retained by the cloth of masks. In the lid closing the empty chamber, the deposition of particles is sought.



(a) (b)

Figure-5. Mask filtration test- a. Validation with surgical mask; b. Observation of deposition of white particles.

RESULTS AND DISCUSSIONS

Inspection of the masks shows that they are made of several layers. Inside, there is propylene, an agent capable of retaining particles by electrostatic effect. Careful observation of Figure-6 proves the presence of a whitish sheet.

Figure-6. Visual inspection of mask constituents.

The air pressure is two (2) bars higher than atmospheric pressure (1.01325 bar). The breathing mechanism translates the phenomenon of inspiration by the penetration of air into the lungs resulting from a contraction of the inspiratory muscles, the increase in the volume of the cavity, the increase in the intrapulmonary volume followed by the decrease in intrapulmonary pressure. The value of 2 bar for the test is higher than the respiratory pressure of the air in humans. It is greater than the pressure of inhalation or exhalation. Although the exhalation pressure is greater than that of inspiration, none of these values exceeds 2 bar.

The masks are subjected to the flame test of a lit candle and placed in the direction of propagation of the blown air. For a surgical mask, taken as a reference, the flame of the candle moves without extinguishing. So all the tested masks shown in Figure-3 and whose candle flame simply moved without going out are similar to surgical masks; On the other hand, those whose flame goes out are therefore too breathable. Nearly 85% of masks manufactured met our expectations.

The result of the filtration experiment is based on the observation of deposits in the lid. Figure-5 shows the presence of a white spot on the mask. This spot is observable in the lid. Such a mask is not filtering; it allows particles to pass through. During the test, only about 20% exhibited this behavior. Filtration performance is not permanent. After a while, the filter loses efficiency due to the loss of pressure electrostatic and clogging phenomena. Washing allows a second life of the mask but the retention rate is reduced. Testing is done in a closed environment.

CONCLUSIONS

The inventory of cloth masks has identified several types. The design of this filtration test and control bench presents the successful manufacture of cloth barrier masks. Tests carried out on the pleated mask showed a rate of about 80% of masks tested. The result is conclusive but remains insufficient because of the particle detection technique. The bench must be equipped with a pressure gauge measuring a lower pressure and a fine particle detector of the order of microns.

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