

# A Study of Comfort Properties Between Various Brand of Face Masks for Malaysian Consumers

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## Abstract

Comfort properties refer to human's impressions after touching an object. The aim of this study is to identify the comfortability properties of knitted face masks from different brands. Comfort refers to a human's impressions after touching an object. Three brands were chosen to test the comfort properties, and physical testing was done to identify the characteristics of each brand. Then the samples from three brands were evaluated for breathability and absorbency to achieve the first objective of this study. The brand that offers low breathing resistance is Brand B. Therefore, consumers who have difficulty breathing will feel comfortable since the water vapour that comes out during the inhale and exhale processes can pass through the mask and not trap inside it. Next, for absorbency properties, it can be concluded that brand C provides the best comfort in terms of absorbency. As a result, the consumer feels comfortable using it because it quickly absorbs moisture from both the outside and inside of the face mask, preventing accumulation.

## 1. Introduction

Comfort is often defined as the absence of uneasiness. Comfort properties also refer to human's impressions after touching an object [1]. A human's psychological response occurs when people touch the object and feel at ease. The brain processes signals from peripheral receptors, including those related to smell, smoothness, consistency, and color, to experience comfort. Psychological, tactile, and thermal comfort were the three main groups under comfort properties. Psychological means of acceptability and the newest fashion trend that is linked with the characteristic of textile comfort were explained by the relationship between the surface of a fabric and its mechanical properties [2]. Thermal comfort refers to the capability of a fabric to keep the skin temperature through the transmission of heat and perspiration created within the individual body [3]. Thermal comfort is an important aspect to consider in knitted fabric. Knitting is the process of interloping a series of yarns that are connected by needles. People formerly used their hands with round or straight needles to knit. Factors influencing the characteristics of knitted fabric are needle size, yarn thickness, yarn type, and knitter skill [4]. There are two main types of knitting: warp knit and weft knit. Knitting produces a fabric that can be stretched to a considerable length, but then it will be back to its original shape, making it not too rigid when worn [5]. Knitted products gave an outstanding comfort feel to the wearer [6]. Knitted fabric is usually chosen since it provides a high degree of comfort and ease of care [7]. Hence, this study helps the customer choose the best brand of knitted face mask based on performance efficiency and comfortability at an affordable price.

## 1.1 Textile Comfort

Comfort is one of the important aspects that needs to be considered when choosing the right clothes to wear. Wearers need to choose comfortable clothing, as the human body releases heat due to temperature differences between the skin and the surroundings. Comfortable clothes make the wearer more confident and flexible when finishing the job because the mind is in an alert state [8]. Comfort is explained by the pleasing condition of psychological, physiological, neurophysiological, and physical harmony between the wearer and the surroundings. Researchers describe comfort as the contact between the wearer and the cloth that is worn, involving thermophysiological, skin sensorial, ergonomic, and physiological aspects [9].

## 1.2 Psychological Comfort

Psychological comfort can be used to describe the satisfying feeling individuals achieve when wearing their clothing [10]. This type of comfort was also hard to test for its presence since it was affected by individual idiosyncrasies. Physical stimuli, a human's mindset, perceptive and emotional developments, surroundings, and cultural and social environments were some of the variables that affect psychological comfort. Psychological comfort is also influenced by the environment and products for the wearer [11].

## 1.3 Tactile Comfort

Tactile comfort is the relationship between the cloth that is being worn and the human's sensory system. It is also involved with the human's feelings when wearing clothing, and some properties that were tested for tactile comfort were bending and draping [12], [13]. Both subjective and objective methods can evaluate textile comfort. Tactile Thermal comfort is one of the characteristics of clothing. It is referred to as the state of mind that represents satisfying action through the thermal environment. Researchers also referred to the relationship between temperature and mass transmission among the wearer and the environment as thermal comfort [14]. Heat and molecule passage, moisture absorption, and the drying capability of the fabric were some other variables that affected the thermal comfort [15]. There were three properties related to thermal comfort: thermal conductivity, heat resistance, and thermal resistance. Thermal conductivity is described by the breathability of the fabric [16]. Meanwhile, heat resistance is the characteristic that avoids heat transfer from the surroundings through the fabric or clothing that is being worn. Lastly, fabric thickness is another term used to refer to thermal resistance [17]. Furthermore, thermal resistance describes the time it takes for heat to transfer in one direction through the fabric [17]. Individuals achieve a satisfying feeling when wearing their clothing, which can be described as psychological comfort [10]. Testing for the presence of this type of comfort was also challenging due to its susceptibility to individual idiosyncrasies. Physical stimuli, a human's mindset, perceptive and emotional developments, surroundings, and cultural and social environments were some of the variables that affect psychological comfort. The environment and products for the wearer also influence psychological comfort [11].

## 2. Methodology

For this study, researchers used a quantitative method to test knitted face masks. Researchers chose three samples of different brands based on market price ranges and availability. Researchers named the selected brands as brands A, B, and C. The price range for all the samples was between RM4 and RM10 per piece, whereas the cheapest brand is brand B, followed by brands A and C. Next, the physical properties of the sample were tested on fibre, yarn, and fabric. Fabric testing was done in this study, and the results were assessed for content and construction by breaking it down into yarn or fibre form and running tests for weight, thickness, and density. The testing followed the ASTM D 3779-1996 standard method. Researchers used a circular weight to extract five specimens within a 100cm section from the full size of the sample. Researchers placed the first specimen on the analytical balance and recorded its weight. The same steps were repeated for the remaining specimens. All the data was calculated to get the average weight reading, which was then multiplied by 100 to obtain the actual weight of the sample per metre in gram per square metre (gsm). Then, the thickness of the sample was determined by using a thickness gauge using ASTM D 3776-96/2002 as the standard method. The anvil of the thickness gauge was placed on top of the sample and lowered until it reached the actual thickness of the sample. All the readings of the thickness were recorded, and the average was calculated to get the actual thickness reading of the sample. The density test was conducted following the MS ISO 7211/2 – 2003 standard method. Five specimens with a size of one inch were taken out of the sample and unraveled to get the total number of yarns in each direction using counting glass. Next, for comfort testing, breathability and absorbency tests were conducted. Absorbency refers to the ability of a textile material to absorb and retain any moisture on its surface. There were two tests that were conducted, which are AATCC 79: Option B: Medicine Dropper Method and AATCC Test Method 22-2005 using the AATCC Spray Tester. The testing was conducted using the medicine dropper method. The medicine dropper method is used to measure the fabric's ability to take up water. There were four specimens needed for each

sample. The sample will be placed in an embroidery hoop with creases on it but avoid making it too tense. Then, a burette dispenser was used to drop the water onto the surface of the sample from the distance that was being decided, which was 9.55 mm above. Researchers will record the time it takes for the water to drop until the specular reflection disappears. The average data of the four samples will be calculated to get the actual reading. Lastly, the AATCC Test Method 22-2005 was tested using the AATCC Spray Tester. Spray tests were conducted to determine the water repellence and moisture repellence properties of fabrics. Three samples were prepared for this testing, each measuring 178 mm by 178 mm. The sample is then placed in a metal hoop of 152 mm diameter to avoid any wrinkles. Then, 250 ml of distilled water was sprayed on top of the sample for 1 minute. Before the rating process started, the sample was held at one edge and tapped against a solid object. The other side of the sample does the same thing. The sample was then rated by at least three evaluators according to the AATCC 22, Spray Test Rating Chart standard method.

### 3. Results

Five tests have been done, and all testing followed the standard. The physical testing is done to get results for weight, thickness, and density, while for comfort properties, testing for breathability and absorbency has been done.

#### 3.1 Physical Testing

Three physical tests were conducted: weight, thickness, and density. All the data is shown below in [Table 1](#).

**Table 1** Physical testing results

Physical Properties	Brand A	Brand B	Brand C
Weight g/m <sup>2</sup>	164.4	128.1	143.2
Standard Deviation	0.030148	0.046789	0.116928
Thickness mm	0.29	0.21	0.43
Standard Deviation	1.001049	0.400499	0.116928
Density (WPCM)	50	34	45
Density (CPCM)	40	35	36
Standard Deviation	0	0	0

The physical attributes of samples from each brand were examined. The weight, thickness, and density of the sample were tested. [Table 1](#) above shows the recorded results during the testing. The standard deviation is used to calculate a summary measure of the variances in each brand's results.

#### 3.2 Weight

The weight of the sample varies by brand. Brand A has the heaviest sample with 6.4041 g/m<sup>2</sup>, while Brand B recorded the lightest reading, which is 2.8137 g/m<sup>2</sup>, and Brand C has a reading of 4.3212 g/m<sup>2</sup>. Due to the thickness and number of courses in the sample, brand A has a higher weight than the other two brands. Thickness and amount of courses per inch were the reasons that could contribute to the fabric weight. Fabric characteristics, for instance, air permeability and thermal properties, can also be affected by the weight of the fabric. Each brand on the graph provides an error bar to demonstrate the accuracy of the supplied data. The standard deviation for the three brands is used to construct the error bar. The error bars in the table below do not overlap with each other, indicating that the data is statistically significant.

#### 3.3 Thickness

Brand A has the thickest sample with a 29.57 mm reading, followed by Brand B sample with a 21.54 mm reading, and the last sample from Brand C with a 12.32 mm thickness reading, making it the thinnest of them. For the error bar obtained, there is also no overlap between them, making the data verified just as statistically significant.

#### 3.4 Density

Stitch density is the number of stitches per unit area. It is calculated by multiplying the number of courses by the number of wales in one inch (2.54 cm). The higher the stitch density, the denser the fabric. Based on the formula, Brand A has the highest stitch density with 2000 wales per cm (WPCM), followed by Brand C, which obtained 1620 WPCM, while Brand B has the lowest with 1190 WPCM. Since the error bars for each brand do not overlap, this data can also be statistically significant.

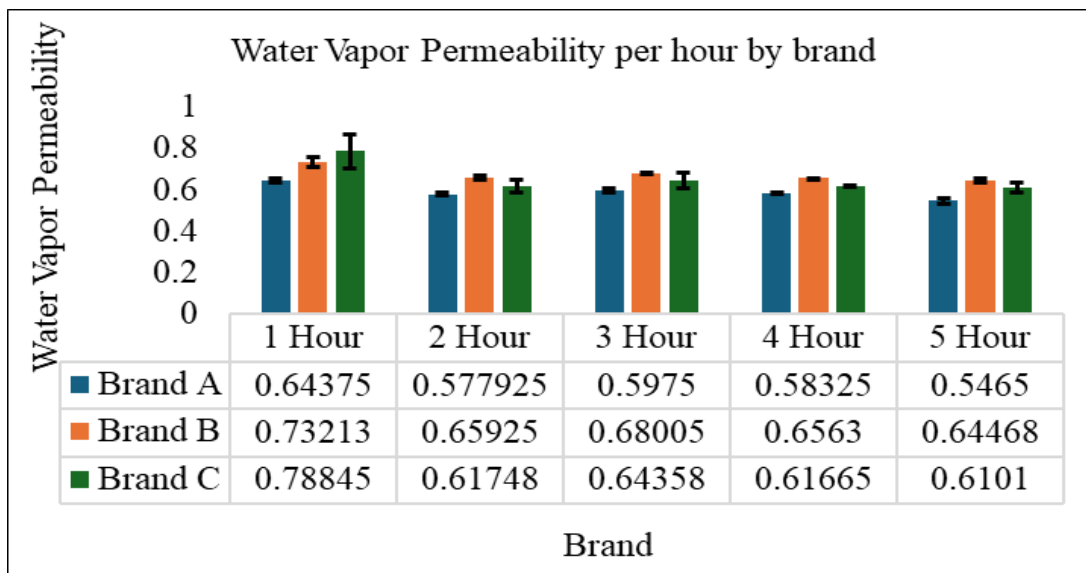
### 3.5 Breathability (Water Vapor Permeability)

Table 2 shows the data collected for the water vapor permeability test per hour. The test lasted for five hours, and the samples required weighing every hour. The face mask is always removed instead of being worn continuously throughout the day.

**Table 2** Water vapor permeability

Hour and Standard Deviation	Brand A (g/m <sup>2</sup> )/hr)	Brand B (g/m <sup>2</sup> )/hr)	Brand C (g/m <sup>2</sup> )/hr)
1 Hour Standard Deviation	0.64375 0.00112171	0.73213 0.00238847	0.78845 0.00825126
2 Hour Standard Deviation	0.57792 0.00071370	0.59250 0.00125135	0.61748 0.00309227
3 Hour Standard Deviation	0.59750 0.00074218	0.68005 0.00049043	0.64358 0.00384590
4 Hour Standard Deviation	0.58325 0.00142389	0.65630 0.00154504	0.61665 0.00175011
5 Hour Standard Deviation	0.54650 0.00141253	0.64468 0.00123342	0.61010 0.00234673




Table 2 and Fig. 1 display the water vapor permeability reading recorded per hour. For the first hour of testing, a sample from Brand C had the highest water vapor reading compared to others, with 0.78845 (g/m<sup>2</sup>)/hr), followed by brand B with 0.7073213 (g/m<sup>2</sup>)/hr) and Brand A with 0.064375 (g/m<sup>2</sup>)/hr). The error bar for the first hour of data collected shows that there is less overlap between the graphs, making the difference in the data less statistically significant. For the second and following hours, samples from Unbranded recorded the highest reading for each hour. It started with 0.065925 g/m<sup>2</sup> for the second hour, 0.068005 g/m<sup>2</sup> for the third hour, 0.065630 g/m<sup>2</sup> for the next following hour, and 0.064468 g/m<sup>2</sup> for the fifth hour of the testing. Brand B has the highest reading. Meanwhile, Brand C has the second-highest reading. Begin with 0.061748 g/m<sup>2</sup>, 0.064358 g/m<sup>2</sup> for the next hour, 0.061665 g/m<sup>2</sup> for the next fourth hour, and 0.061010 g/m<sup>2</sup> for the last hour of the testing. Brand A has the lowest water vapor permeability reading. The reading for the second hour of testing is 0.057792 g/m<sup>2</sup>, followed by 0.059750 g/m<sup>2</sup> for the third hour, 0.058325 g/m<sup>2</sup> for the next following hour, and 0.054650 g/m<sup>2</sup> for the fifth hour. The standard bar for the second to fifth hours is the same as the first hour, where there is a bit of overlap between the graphs, making the difference in the data less statistically significant.



**Fig. 1** Water vapor permeability per hour

Table 3 shows the average water vapor permeability for each brand. The first and last readings during the five-hour test are calculated together to get the water vapor permeability reading.

Table 3 Average water vapor permeability

Sample	Weight loss (before) (g)	Weight loss for Fifth hour (after) (g)	Weight loss (g)	Water Vapor Permeability (g/m <sup>2</sup> /h)
Brand A 	126.389	125.386	1.003	2.9479
Brand B 	126.377	125.230	1.147	3.3739
Brand C 	128.762	127.648	1.114	3.2751

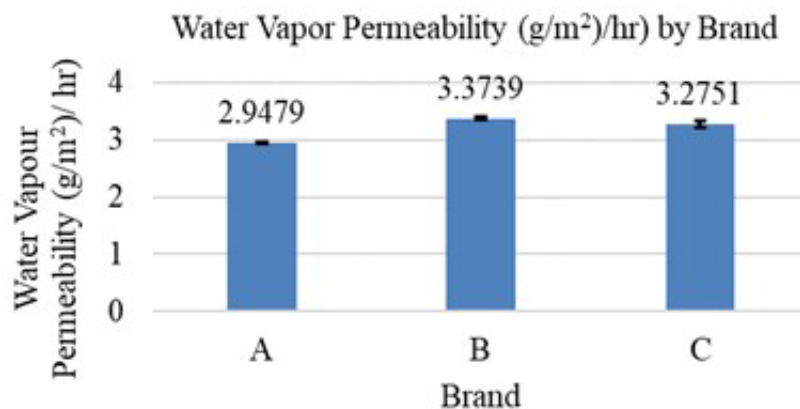





Fig. 2 Graph relationship between water vapor permeability for different brands

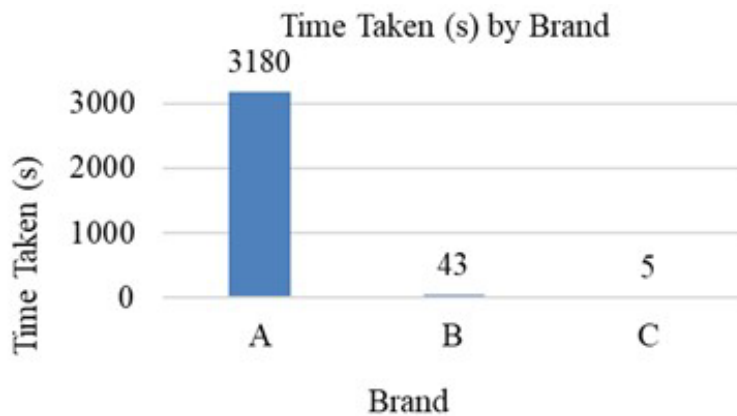
Breathability was tested by using a water vapour permeability tester. From the results (Fig. 2), the highest reading recorded for this testing is by Unbranded with 3.3739 (g/m<sup>2</sup>)/hr while the lowest is by Brand A with 2.9479 (g/m<sup>2</sup>)/hr followed by Brand C with 3.2751 (g/m<sup>2</sup>)/hr). Brand B allows better water vapor transmission since it has the lowest stitch density; hence, the amount of water vapour can evaporate quicker compared to other brands. The lower the stitch density, the less compact the fabric will be. Therefore, the gap between each yarn in the sample is far from each other, providing a space for the water vapor to transmit outside from the face mask, which results in good comfort for the wearer. Higher stitch density in the fabrics leads to lower water vapour permeability.

### 3.6 Absorbency (Wettability Test)

Table 4 and Fig. 3 display the graph illustrating the sample's absorption time for the droplet in seconds. Brand C takes less time to absorb the droplet compared to others. This is because samples from Brand C are the thinnest. It may also be one of the reasons that it takes a shorter time. Regardless of fibre type, fabric thickness is the most important element in determining fabric absorption capacity. Whereas samples from Brands A and B were recorded for a longer time since they have thicker samples compared to those from Brand C. The thickness of the sample greatly affects the liquid moisture transport properties.

**Table 4** Average time taken for the three samples

Sample	Average Time Taken (s)
Brand A 	3840
Brand B 	43
Brand C 	3




**Fig. 3** Graph relationship between time taken of water drop absorb into the fabric for different brand

### 3.7 Water Spray Rating

Table 5 and Fig. 4 show ratings for the spray test method and the average water spray rating by brand. Rating 90 is recorded by brand A, while brands B and C share the same rating, which is 70. The lower rating means that brands B and C have less water repellency and moisture repellency properties. This is due to a thin sample of both brands. It also means that these brands have high absorbency properties compared to brand A. Fabrics that were dense and thick have resulted in lower absorbance to the structure.

**Table 5** Rating for spray test method

Sample	Average Rating
Brand A 	90

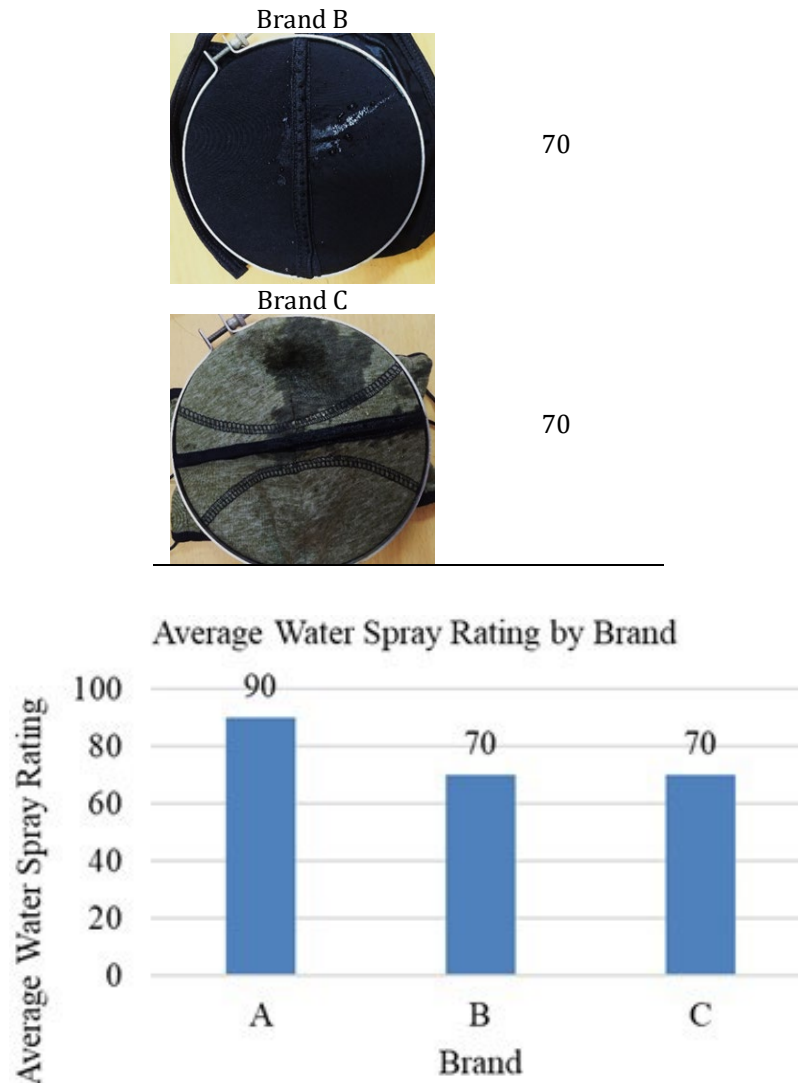


Fig. 4 Average water spray rating by brand

#### 4. Conclusion

In this study, three different brands of knitted face masks were chosen and evaluated for its comfort properties by conducting water vapor permeability per hour testing and absorbency testing. The brand that offers low breathing resistance is Brand B. Therefore, consumers who have difficulty breathing will feel comfortable since the water vapour that comes out during the inhale and exhale processes can pass through the mask and is not trapped inside it. Next, for absorbency properties, it can be concluded that Brand C provides the best comfort in terms of absorbency. Thus, Brand C provides the best comfort in terms of absorbency, allowing the consumer to feel comfortable using it as moisture from the outside and inside of the face mask is quickly absorbed instead of accumulating.

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#### Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

#### Author Contribution

In this work, **comfort properties testing** was done by Nasa'ie Zainuddin, Najua Tulos and Syaiful Osman. **Editing** was done by Muhammad Hisyam Zakaria supported by Asliza Aris. All authors reviewed the results and approved the final version of the manuscript.

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