

A Correlative Study Between Consumer Perception and Comfort Performance of Undergarment Fabrics

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Abstract—Fabric comfort is a crucial aspect for undergarments that is worn in tropical climates that creates an environment with soaring temperatures and high humidity can cause the conservation of heat, sweat retention and overall discomfort. Consumers often judge fabrics through their hand feel and physical appearance, but these observations may not completely reflect their comfort in terms of the performance metrics. This study therefore targets to investigate the objective comfort performance and the consumer's subjective perceptions of different undergarment fabrics under tropical conditions. There are five fabric samples of undergarments that have varying fibre compositions and physical properties were evaluated accordingly. The basic physical properties such as fabric thickness and density as well as the fibre identification were first discovered. Subsequently, the comfort performance of the samples was assessed through air permeability, water vapour transmission and lastly moisture management testing. The results from all laboratory tests were normalized and combined to produce an overall laboratory comfort performance index (OLCPI). A survey was conducted to look at the consumer perception where 39 valid respondents ranked the five samples according to five comfort-related questions based on the visual aspect and tactile assessment. The Pearson correlation analysis was later used to establish the relationship between laboratory performance and consumer preference. The overall results prove that Sample B attained the highest air permeability (1471.43 mm/s), water vapour transmission (5.21 g) and OLCPI (0.886). These outcomes reveal that Sample B exhibits the most balanced and proportional overall comfort performance. Although Sample E displayed the highest liquid moisture management result, its low air permeability and moderately low water vapour transmission led to the sample having the lowest OLCPI value (0.365). Moreover, the consumer survey generated a similar overall ranking, with Sample B being the most preferred, then followed by Sample D, C, A and lastly E. Sample B recorded the highest consumer preference score (4.082), whereas Sample E has the lowest score (1.733). There is a strong positive correlation ($r = 0.874$) was found between the laboratory performance and consumer perception. The results imply that laboratory testing can provide a significant insight of consumer's perception of comfort. Nevertheless, there are also other factors that can influence the evaluations done by consumers such as smoothness, softness, flexibility and texture of the fabric. Hence, both of the testing and consumer perception must be accounted for when selecting and developing undergarment fabrics that is suitable for the hot and humid tropical conditions.

Index Terms—Undergarment fabrics, fabric comfort, Consumer perception, tropical conditions, Air permeability, Moisture management.

1. Introduction

Comfort in clothing is a state where someone feels neither pain nor discomfort which is of the view that this is due to a balance between physiological, psychological and physical factors between the person and the surroundings (Kamalha, A. et al., 2013). Physical comfort, which entails wearing comfortable things, assists individuals to move autonomously, retain individually cold or hot, and get rid of body sweat (Kaplan, S., 2008). One can say the same in the comfort of undergarments since it is a method of improving the overall health and well-being to everyone. Comfortable and well-designed undergarments are significant because it is helpful in avoiding skin irritation, in addition to restricting movement and decreasing the risks of infections related to the presence of moisture and microorganisms (Alves et al., 2013). One of the problems, in this case, is related to a sense of comfort in the conditions of tropical climate when climatic temperature is high, and humidity is also high. The association, which is present between the human body, garment and the surrounding, causes the cloth to be either comfortable to wear or not. Inadequately designed and slow-moving air flowing fabric can lead to heat retention and ineffectiveness and properly designed breathable and moisture management fabrics can lead the wearer to be comfortable.

That is, this research employs two perspectives to examine the problem of undergarment comfort that encompasses conditioned consumer subjective perception and objective test of fabric performances. The subjective is the preference of the consumers on the fabric in terms of the air permeability, moisture, and water vapor transmission appearance of the product. Simultaneously, objective side researches, and analyses the quantitative features of fabrics through the form of air permeability, water absorption and water vapor transfer in the lab. Nonetheless, it is paramount to undertake some basic physical properties (weight and thickness) and fabric structure before performing the tests pertaining to the comfort on the

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fibre types. This study thus tries to determine the association that exists between perceived comfort and physical comfort attributes of the different undergarment cloths by comparing the results that emerge out of the two of these objective and subjective methods. Similarly, this integrative method will connect the interrelation between science accuracy of measuring and consumer perception, which can be used to aid in enhancing the research on fabric comfort.

This study demonstrated the identification of a specific correlation between the laboratory identified comfort features and the subjective comfort rating by consumers. This means that the consumers are more knowledgeable about the suitable fabrics can be used in tropical weather and understand the difference in perception of the comfort of different make-ups of materials. Lastly, the findings from this study provide a better understanding of how the fabric characteristics influence undergarment comfort and may assist textile manufacturers and designers in developing fabrics that are more suitable for tropical environments. Thus, it may result in the introduction of

the necessary materials to be able to create undergarments in the tropics and equip buyers with adequate information to select the appropriate style of clothing, which is comfortable and appropriate to the weather. In addition to this, the results can further the research on textiles in general due to their emphasis on the necessity of using both technical and human-based approaches to studying the notion of comfort.

2. Background of the Study

A. Clothing Comfort in Tropical Conditions

Clothing garment is a concept that is multidimensional in nature, and it demonstrates the responds of the wearer towards the physical and the psychological properties of the fabric when it is worn and used. Due to this reason, the comfort need is essential in hot and humid areas like the Southeast Asia. This is given the fact that the environment puts additional thermal pressure to the human body. The undergarment is a clothing next to the skin rather, which is crucial in the process of controlling the microclimate between the clothing piece and the body. Depending on the performance of the fabric, the wearer feels cold, dry, breathable, or uncomfortable. In particular, one study emphasizes that comfort cannot be quantified with the help of a single factor since all of the following attributes can have an impact on the wearer experience: ergonomic, tactile and thermal (Li et al., 2020). Therefore, the comprehension of these dimensions of comfort is crucial to materials choose to use in the creation of undergarments that would be suitable in tropical climate.

When it comes to tropical climatic conditions there exist a number of environmental factors that can be brought to task when it comes to determining the sensation or feeling of clothing comfort. The high temperatures will lead to more production of sweat and the high level of humidity will not allow the evaporation of sweat, which is regarded as the main cooling system of the body. This will create an outcome of the material used in the clothes that do not permit sufficient movement of air and moisture will therefore retain the heat and

moisture which will lead to discomfort, skin irritation, and even stickiness. Kim (2021) argues that fabrics that have low moisture vapor transmission inhibit the body to deal with the heat, particularly in hot seasons. Therefore, the materials used in contact with the body should be able to contain moisture, be breathable, and lightweight.

B. Tactile and Sensory Comfort

Textiles with smooth and soft touch produce a good and pleasant feel, whereas coarse and rough textiles can irritate, especially when one is wearing it in a long duration of time. In order to provide a systematic quantification of such subjective sensations, other researchers have adopted the tools such as the Kawabata Evaluation System (KES) that measures the most important mechanical attributes of a fabric which are; surface friction, bending rigidity and compressibility. The fact that a person feel comfortable is directly related to the physical characteristics of the material has been replicated by other studies by Utkun (2021), who have confirmed the high correlation between objective parameters of KES and the subjective human emotion. Elasticity is also used to explain what it is like to feel undergarments. Elasticity and recovery is

also added by the introduction of fibres such as spandex hence improving the level of comfort and mobility. Good design is supposed to offer a good balance between elasticity and enough amount so that it is tight without being tight to the extent of constriction especially in the areas where it is likely to rub and move (Kanai, H., 2021).

One must also keep in mind that the feeling of the mechanical comfort is not entirely mechanical but incorporates immediate sense of cold such as so-called cool touch of smooth, synthetic or moisture-wicking garments. To provide a contrast, certain materials such as cotton that may be soft and easy to touch when dry, can get heavier and damp when wet with sweat. These active and even contradictory features indicate the applicability of the holistic approach to fabric properties when developing undergarments to wear in the tropics (Islam, M.R., 2023).

C. Textile Properties that affect Comfort of Undergarments

Comfort in clothes starts with the choice of the appropriate fibre. All the kinds of fibres, natural, synthetic, or regenerated, have their specific character, which is used to create the fabric, and which affects the way the fabric breathes, moves, and releases heat. Cotton is the first fabric that is always preferred because it has a natural softness, breathable and very absorbent. It readily absorbs moisture, and it gives a cool effect at first. However, when used in the wet or sporting conditions the slower rate at which cotton dries can result in the fabric becoming sticky against the skin as has been noted in high-exertion settings. Polyester on the other hand is greatly valued due to its strength and light weight as well as ability to dry quickly (Das, B, 2007). Such technology as microfiber technology has been developed with advanced engineering to actively collect moisture away using polyester. But to others, the perceived disadvantages of polyester as a garment include the high-tech nature against the perceived natural breathability of its botanical counterparts. Nylon has a good wicking

behavior, gives strength to fabric, and adds smoothness to it (Hu. J., 2005). Nylon is a material that is resistant and soft enough, thus making the material a reliable one, particularly when one would want to combine the material with other materials as long as the strength and comfort is the main aim as in the case of body-hugging lingerie.

This feeling of comfort of the clothing is not only produced by the fibres but is also determined by the structure in which the fibres have been woven. The blueprint of the fabric, which is the primary entry of the interaction between skin and environment, is fabric structure (Li, Y., 2001). This predetermines the directions of the breathability, the connection of the fabric and the moisture, and the end result is the way the fabric feels to the skin. Undergarment design is made up of the knitted material, which consists of loops of interlacing yarns (Spencer, D. J., 2001). The elasticity of this fabric is also dynamic and is not usually found in woven fabrics as the natural properties of this fabric enable the fabric to stretch and rebound

with the movements of the body. This coziness of this soft embrace is connected directly to its original design. It is in this knitted family where the specialty of the mix of the stitches creates a specific comfort profile. Indicatively, one jersey knit can produce a lightweight and breathable fabric, with the high

level of flexibility, which makes it the knit of choice when it comes to hot weather wear. The rib knit which is its more elasticated form is highly stretchable and recovers so as to be used on cuffs, waistbands and any part of the garment that demands a high degree of support and a tight fit. An interlock knit, however, has a smoother, more non-slippery wear, but without a certain level of breathability than its counterpart of single jersey (Manshahia, M., 2014).

3. Methodology

The materials and equipment used during this research study were selected to an optimal extent to help in the evaluation of the comfort aspects of undergarment fabrics in a tropical climate. Five categories of undergarment fabrics frequently used were chosen to be the fabrics which are also frequently worn in the tropical conditions and to help conduct variations in the test results concerning breathability, moisture absorption, elasticity and moisture control. The assessment of the objective comfort performance of the chosen fabrics was conducted with the help of the laboratory equipment including an air permeability tester, a water vapour transmission tester, and a moisture management tester (MMT), which are based on the availability of the equipment in the laboratory. Thus, the materials and equipment allow making the comfort properties of undergarment fabrics assessed systematically. These materials are selected strategically since they are the normal materials of the undergarments worn in tropical climates and differ in breathability, absorption and control of moisture. Five common undergarment types of fabric were chosen:

- 94% Cotton, 6% Spandex blend
- 95% Cotton, 5% Polyester blend
- 95% Polyester 5% Spandex blend
- 95% Modal 5% Spandex blend

• 100% Polyester

Depending on the equipment that is available in the testing facility, several laboratory equipment were used to establish the objective comfort properties of the chosen fabrics. An air permeability tester was used to find the rate of airflow out and through the fabric and hence the breathability of the fabric. The capability of the fabric to make the escape of the perspiration vapor which is critical in keeping the cloth dry were tested by a water vapor transmission tester. Besides that, a Moisture Management Tester (MMT) were utilized to measure the wetting time, absorption, spreading rate, and the total wicking capacity of the fabric to study the behaviour of liquid moisture.

In this research, the researcher uses a quantitative correlation approach in order to test the connection between the real comfort characteristics of underwear fabrics and those that consumers experience when wearing them in the tropics. This research shall consist of two key elements which are laboratory testing and consumer survey. To begin with, they carry out laboratory tests on some of the underwear fabrics to find out whether they are performing the job properly in terms of the comfort properties which include air permeability, water vapor transmission as well as moisture management. The tests give tangible information regarding the comparisons of the fabrics in terms of heat and moisture. In the meantime, a survey of consumers was conducted to find out how consumers feel about the fabrics, and the ways they appear without putting them on. The statistical analysis was used to establish a correlation between the two and come to a good opinion on the effect that the actual properties of the fabric have on the perceived comfort.

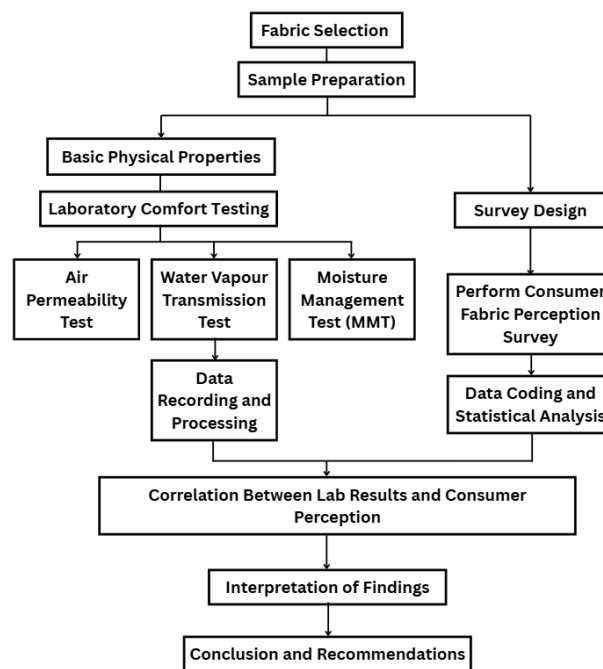


Fig. 1. Flow process of the study

4. Results and Analysis

A. Basic Physical Properties

The physical properties evaluated included fabric thickness, fabric weight (mass per unit area), and fabric density. Measuring these properties provides important baseline information that helps explain the differences observed in the laboratory comfort tests and consumer perception results (Kadolph, 2020).

B. Laboratory Evaluation of Fabric Comfort Performance

The laboratory evaluation was performed to objectively determine the performance in terms of comfort of the selected undergarment fabric samples using three standardised comfort-related tests. The three tests conducted are water vapour transmission, air permeability and overall moisture management capacity (OMMC).

1) Water Vapour Transmission

Water vapour transmission performance was evaluated to determine the ability of each fabric sample to allow moisture vapour to pass through the material. This property is important for undergarments used in tropical climates because effective moisture vapour transfer helps reduce sweat accumulation and improves wearer comfort. Fig. 2 presents the water vapour loss values obtained for each fabric sample. The data shows that Sample B achieved the highest water vapour transmission with a mean weight loss of 5.21g. Sample A also performed well, yielding a loss of 5.13g. The lowest transmission capability was observed in Sample D, which restricted moisture transfer to a mean mass loss of 4.25g.

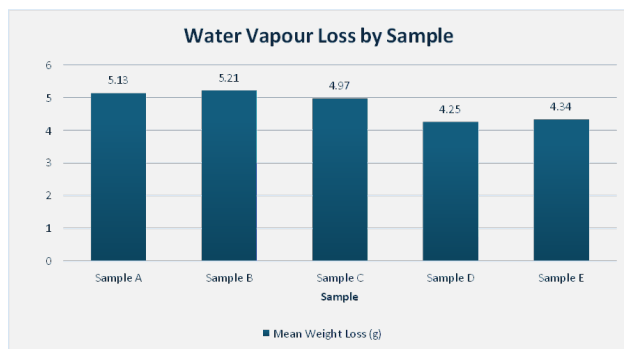


Fig. 2. Water vapor transmission

Gaseous moisture transfer through a textile material operates primarily through passive molecular diffusion across air-filled interstitial spaces, a mechanism governed fundamentally by Fick's Law of Diffusion. According to this physical principle, the rate of diffusion is inversely proportional to the path length (fabric thickness). Because thinner materials offer a shorter distance for migrating gas molecules, they exhibit lower resistance to vapor movement (Nagy Szabó et al., 2023).

This principle explains why Sample B (0.37g) performs so well, as its thin profile allows water vapor to escape efficiently into the surrounding environment. However, fiber type and yarn composition can also alter this behavior. While Sample D is relatively thin (0.38g), it recorded the lowest vapor transmission rate (4.25g). This indicates that Sample D likely incorporates hydrophobic synthetic fibers or a dense, tight yarn twist that physically blocks vapor diffusion and traps moisture, despite its thin profile (Asfand et al., 2024).

2) Air Permeability

Air permeability analysis was conducted to evaluate the ability of the fabric samples to allow airflow through their structures. Fabric breathability is strongly influenced by factors such as fiber composition, fabric construction, thickness, and porosity. Higher air permeability generally indicates better airflow movement, which may contribute to improved thermal comfort, particularly in warm and humid conditions. Fig. 3 illustrates the air permeability performance of Samples A–E. The empirical results demonstrate that Sample B achieved the highest airflow velocity at 1471.43 mm followed closely by Sample D at 1257.80 mm. In contrast, Sample E demonstrated the lowest air permeability rate, 451.50 mm.

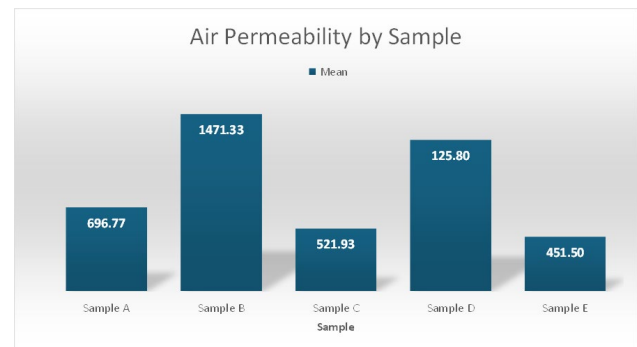


Fig. 3. Results of air permeability

The substantial differences in performance are closely linked to the physical and structural properties of the materials, specifically fabric thickness and fabric weight (g/m). Textile structures govern fluid flow based on internal aerodynamic resistance. Thick, dense fabrics restrict air molecule migration by creating a longer, more tortuous path through the interlocking fiber matrix (Havlová, 2020).

When these results are correlated with the structural parameters of the materials, Sample B has the lowest thickness (0.37 mm) and lightest fabric weight, which minimizes aerodynamic resistance and leaves a highly open pore structure for unhindered airflow. Conversely, Sample E possesses a higher structural thickness (0.46 mm) combined with a higher fiber mass concentration. This dense configuration compresses the inter-yarn spaces, reducing overall porosity and drastically

Table 1
Basic physical properties for selected undergarment fabrics

Sample I.D.	Thickness (mm)	Weight (g/m ²)	Fiber composition
A	0.64	193	94% Cotton, 5% Spandex
B	0.37	116	95% Cotton, 5% Polyester
C	0.43	184	95% Polyester, 5% Spandex
D	0.38	124	95% Modal, 5% Spandex
E	0.46	193	100% Polyester

choking the airflow velocity passing through the textile matrix (Vasile, 2024).

3) Moisture Management Test (MMT)

Moisture management performance was evaluated to determine how effectively each fabric sample absorbs, transports, and spreads liquid moisture. This property is essential for undergarments because efficient moisture movement helps maintain dryness and prevents uncomfortable wetness against the skin. The results from the laboratory testing of Moisture Management test (MMT) isolate Sample E with the rest of the samples as the top performing material for liquid moisture management, attaining a high OMMC score of 0.621, which places it definitively in the "Excellent" or "Best" performance category. Conversely, Sample A recorded the lowest liquid management capacity, with an OMMC index of 0.4464.

The outstanding OMMC rating of Sample E is driven by a highly active capillary wicking profile. Effective moisture management fabrics are engineered using a modified blend of hydrophilic and hydrophobic fibers, or specialized knit patterns that generate a strict capillary pressure gradient between the top and bottom layers (Idris *et al.*, 2024).

Sample E utilizes this structural layout to establish a highly directional moisture draw as it rapidly absorbs sweat droplet clusters from the inner skin-contact and immediately forces that liquid through to the outer face, where the moisture spreads immediately across expanded surface area to quick evaporation. However, Sample A demonstrates a low OMMC score. While it can absorb liquid on the top surface, it lacks the internal capillary driving force required to push moisture outward. This deficiency causes liquid to remain trapped on the inner face next to the wearer's skin, a state that leads to high tactile discomfort, skin chafing, and post-exercise chill (Vasile, 2024).

4) Overall Laboratory Comfort Performance Index (Composite Score)

The overall laboratory comfort performance index (OLCPI) was calculated by combining the results obtained from the individual comfort tests, including water vapour transmission, air permeability, and moisture management performance. This combined index provides an overall comparison of the comfort capability of each fabric sample rather than evaluating individual properties separately. Fig. 4 shows the overall laboratory comfort performance ranking of Samples A–E.

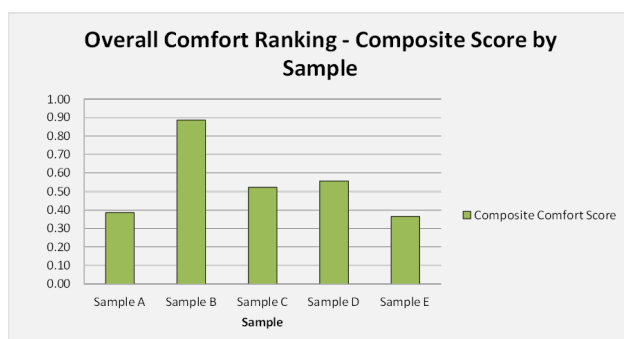


Fig. 4. Overall comfort rating

The results of the three laboratory tests, air permeability,

water vapor transmission and moisture management (OMMC) were all combined to give an Overall Laboratory Comfort Performance Index that would provide a complete assessment of the comfort performance of the selected undergarment fabrics. Each test was measured on different units and scales, so the data were pre-normalized by min-max normalization and then the average of the three pre-normalized values was calculated. This method led to a total evaluation of the comfort parameters in an equal manner and directly comparable with the five fabric samples. Comfort is a multidimensional property and has been recognized as such in textile and material performance studies which have used similar composite index approaches to enable multi-performance indicators to be combined into a single evaluation (Li, 2001, Hes, 2008). Sample B had the highest Overall Laboratory Comfort Performance Index (OLCPI) value (0.886), which means it is the most comfortable fabric of the five samples. This was due to the excellent air permeability and water vapor transmission, which it was the best at, and a relatively high moisture management capacity. The graph combined properties lead to the possibility of efficient airflow through the fabric, easy transfer of perspiration vapor through the fabric and good liquid moisture control, which are all desirable characteristics for maintaining a comfortable microclimate between skin and fabric. According to Qian (2016), numerous studies have demonstrated that high air permeability and good moisture transport are among the most important factors that affect clothing comfort due to the ability to dissipate heat and minimize moisture build-up during wear. Thus, the higher composite score for Sample B indicates that it has the most balanced comfort-related properties.

Sample D came in next with 0.557. While it had the lowest water vapor transmission of the five samples, its relatively high air permeability and good moisture management performance made up for this. This illustrates that there are no single laboratory properties that can define overall comfort; rather, comfort is a product of multiple fabric properties. This finding confirms the idea put forward by Hes (2008) that the parameter of clothing comfort should be assessed based on both thermal and moisture performance parameters. The composite score for samples C and A was intermediate at 0.522 and 0.386, respectively. The moisture management performance of the samples was good, with Sample C having a higher value than Sample A, but Sample A had a lower moisture management value than Sample C, although the air permeability was higher. The results suggest that there are strengths in some comfort properties that can be counterbalanced by the weaknesses in the other, suggesting the need for multi-parameter evaluation of comfort. Based on this laboratory evaluation, the Overall Laboratory Comfort Performance Index (0.365) was the lowest of all the fabrics, making it the least comfortable sample. While Sample E exhibited the greatest moisture management capacity, its low air permeability and comparatively low water vapour transmission resulted in a lower performance in terms of comfort. This discovery indicates that there is no direct correlation between good performance in one of the comfort parameters and good overall comfort. It is not possible to enhance a single property of clothing (breathability, moisture

vapour transport or liquid moisture management) for the best effect on clothing comfort (Li, 2001, Das & Alagirusamy, 2010).

In general, the composite index was a practical and objective way to combine the three laboratory comfort tests into one performance index. The results have shown that the overall comfort performance of the laboratory for Sample B is the best while the overall comfort performance of the laboratory for Sample E is the least comfortable. This is because clothing comfort is a widely accepted multi-dimensional concept affected by various interacting physical properties, which makes it suitable to measure comfort using a composite comfort index. The combined laboratory measurements into a single index facilitated the direct comparison of the overall comfort.

C. Overall Consumer Preference Ranking of Samples

Consumer perception evaluation was conducted to determine how respondents perceived the comfort characteristics of the selected undergarment fabrics. The assessment considered factors such as softness, breathability, moisture sensation, and overall comfort preference. The results were compared among Samples A–E to identify the fabric sample that was most preferred by consumers. Fig. 5 presents the overall consumer preference ranking.

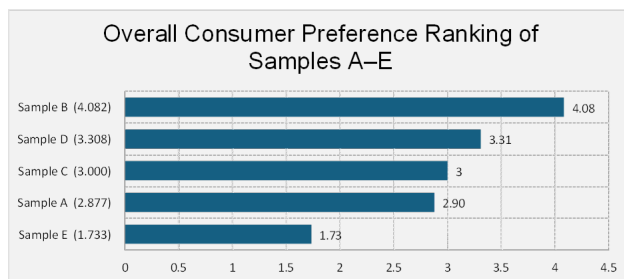


Fig. 5. Overall consumer ranking

A composite mean-rank method was used in order to help determine a more comprehensive consumer preference grading. Five comfort-related questions were answered by each of the respondents ranking all of the samples, from Sample A to sample E. A rank of 1 depicted as the most preferred sample, whereas a rank 5 described as the least preferred sample. The data for the questionnaire were regarded as repeated measures ordinal ranking in preference to independent numerical ratings considering that the same respondents evaluated all of the five samples.

Before starting an analysis, the responses were inspected for two criteria, the completeness of the data as well as the validity of the ranking system. The incorporation of each rank from 1 to 5 precisely once across all samples. Inopportunely, there is one respondent's answer specifically for Question 5 include a duplicated rank and a missing rank. Therefore, the answer for that one respondent's answer was kept out from the overall composite analysis instead of being attributed.

Accordingly, 39 of the complete respondents were used for the overall ranking where each of the five criteria of the questionnaire was given equal weight that produces 195 valid rank observations for each sample:

$$39 \text{ respondents} \times 5 \text{ questions} = 195 \text{ rankings per sample}$$

The values of the rank were allocated to each sample were first augmented to acquire the rank sum. The overall mean rank was then calculated detailed as follows:

$$\text{Overall Mean Rank} = \frac{\text{Total Rank Sum}}{195}$$

A lower mean rank showcases a stronger consumer preference as rank 1 is the most preferred or favorable response. Mean-rank analysis is a proper and apposite for the order of rank data because it preserves the ordinal direction of the responses while not assuming that the numerical distance between consecutive ranks is an equal physical quantity. There is also consistency for the usage of ranks with the logic of non-parametric repeated measures analysis that is presented by Friedman (1937).

The transformation reverses the overall direction of the scale so that a longer bar indicates a grater preference. By the way of illustration, a mean rank that is close to 1 creates a preference score close to 5 while a mean rank close to 5 develops a preference score close to 1. This specific transformation that is being used does not change the order of the samples, but it is used to make the graph easier to interpret. Hence, the mean rank stays the primary statistic for determining the final ranking.

Fig. 5 gives a definite general ranking of consumer preference for the five fabrics. The overall mean rank of Sample B was 1.918 and the Preference Score was 4.082, which is the highest. Sample D was ranked second with a mean rank of 2.692 and a Preference Score of 3.308. The mean rank and Preference Score of Sample C was 3.000. Sample A had a mean rank of 3.123 and a Preference Score of 2.877 which was the 4th position in the ranking. Sample E had the highest mean rank (4.267) and the lowest Preference Score (1.733) and was ranked 5th and last of the five samples. Thus, the order of preference starts with Sample B, Sample D, Sample C, Sample A and Sample E.

The mean rank for sample B was 1.918, which was close to the most favorable possible mean rank of 1.000. This means that, on the five comfort-related criteria, the comfort ratings for Sample B were often scored high on the preferred end of the rating range. The relative separation between the first ranked sample and the second ranked sample was relatively clear with its Preference Score about 0.774 points higher than that of Sample D. The clear favor for Sample B indicates that the respondents liked the sample best overall, due to the initial sensory qualities of the sample to the eyes and hands. The survey was done blind labelled where respondents were not told the fiber composition or the expected technical performance. The consumers were relying on visual and tactile information. The consumer can rely on tactile qualities such as softness or smoothness, pliability or thickness, and surface texture, as well as apparent openness of the fabric structure, and cooling to the touch.

Sample D was generally good but not among the top responses, with a mean rank of 2.692. The middle part of the

graph was taken by Sample C and Sample A. The mean-rank difference between Sample C and Sample A was relatively small at 0.123, when compared to the differences between Sample B and Sample D and between Sample A and Sample E. It is evident that although Sample C was descriptively ranked above Sample A, the overall consumer preference for the two samples was relatively similar. Sample E was distinctly different from the other samples. The mean rank of 4.267 was more towards the less favorable end of the ranking scale than towards the neutral center of the scale. The Preference Score for this sample was 1.144 points lower than that for the next lowest sample, Sample A. This finding shows that sample E was always rated less favorably when all the 5 comfort-related criteria were combined together.

Overall, the results of the consumer perception tests show that Sample B is the preferred fabric sample followed by Sample D and then Sample C and Sample A and least preferred Sample E. The results show that there is a clear pattern of preference among consumers on the five comfort-related criteria. However, since the assessment was carried out based on immediate sight and hand feel, and not by an actual wear trial, the assessment results should be termed as 'Subjective Perceived Comfort'. The final decision on suitability for use in tropical situations should be based on the conclusions drawn from this consumer ranking in conjunction with the objective air permeability, water-vapor transmission and moisture-management data.

D. Correlation Between Overall Consumer Perception and Overall Laboratory Comfort Performance Index (OLCPI)

The correlation analysis was conducted to determine the overall relationship between consumer perception and the combined laboratory comfort performance index (OLCPI). This analysis provides an overall understanding of whether fabrics with better laboratory-measured comfort performance are also preferred by consumers. Fig. 6 presents the correlation between overall consumer perception and OLCPI.

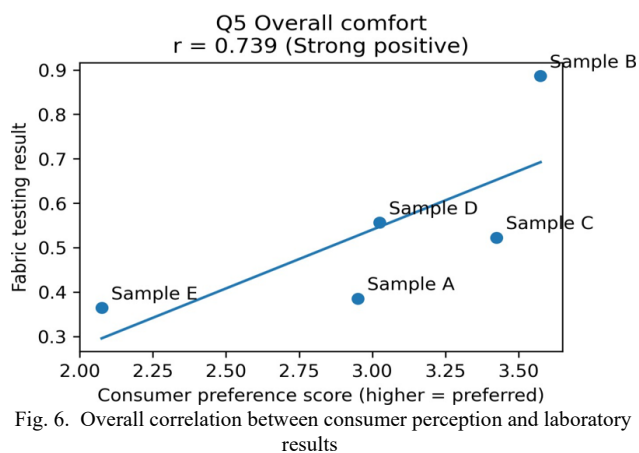


Fig. 6 shows a correlation graph between laboratory comfort performance and consumer perception with a positive slope along with the correlation of $r = 0.874$ in which showcase that the objective laboratory results as well as the subjective

consumer assessment. This research supports recent textile research by Lee, S. (2024) that proves a measured fabric properties can also be compared with the subjective tactile evaluations in order to ascertain if the measurable parameters correlate with human sensory responses. The study has the combination of objective parameter measurements alongside the subjective evaluations of fabric and found a significant and substantive correlation between the classifications that are equipment-based and the sensory analysis or evaluation.

Sample B's strong and high position establishes that its measured comfort through lab testing was also reflected well in the consumer preference. The experimental conditions may have fabricated sensory cues that respondents might have associated with comfort. Nevertheless, the correlation graph alone cannot produce exactly which of the individual physical property may have caused the respondent's preference to the sample.

The preference of a specific sample by consumers is impacted by more than the technical moisture and performance of airflow. A recent study by Park, S. (2024) proves that sensory factors such as smoothness, flexibility, thickness, textures as well as subjective perceptions are involved when discussing consumer's responses to fabrics. Subjective sensory experience can influence preference as well as the evaluation of the product although consumers do not know the technical composition or textile specifications of the fabric.

Sample A and E are excellent examples of why subjective evaluation remains important. Although both samples are relatively similar in terms of the laboratory parameters, Sample A showcase a significantly and noticeably higher consumer preferences score in comparison to Sample E. The differences of the consumer preferences score proposes the fabric may have produced different tactile or visual aspect irrespective to the comparable laboratory composite score. The perception of fabric can vary in correspondence to physical contact and visual impressions as well as the context in which the overall assessment is conducted. According to a recent study by Jang, S. Y. (2024), mentions that the confidence in fabric judgement or assessment does not necessarily correlate perfectly with the objective measurements or parameters.

The correlation graph shows that fabrics that perform better in terms of laboratory testing are also preferred compellingly by the consumers. Sample B is the most comfortable for the overall sample as it achieved the highest score in both objective laboratory analysis and subjective evaluation by the consumers whereas Sample E is the least comfortable because it has the lowest score under both methods. Therefore, the strong positive Pearson correlation confirms that the laboratory testing can give a significant indication of the consumer-perceived comfort. However, it is important to note that consumer perception is multidimensional and can be influenced by the tactile, visual and psychological factors that are not fully represented by the lab testing results.

5. Conclusion

This study was carried out because there is a need to find better understanding of the comfort performance of

undergarments in the tropics and to scrutinize the relationship between an objective evaluation of the fabrics comfort performance and their subjective assessment by consumers. Consumer acceptance is not always a direct function of the measurable physical properties, although fabric comfort can be measured using laboratory testing.

Thus, the purpose of this study was to close the gap between the comfort evaluation in laboratory tests and consumer perception of comfort, examining if laboratory comfort evaluations match consumer's perception of comfort. Both laboratory evaluations and consumer perception analysis were applied, which were used to fulfill the objectives of this study. This study successfully determined the differences in terms of comfort performance for the selected undergarment fabrics and relation between the fabric attributes and the consumer preference. The results indicate that there is a complementarity of objective performance evaluation and subjective evaluation in understanding the feeling of textile comfort. In addition, the question of whether the laboratory comfort performance translates into consumer's comfort perception was also explored and laboratory measured comfort performance is generally correlated with more positive consumer comfort perceptions. This study has attempted to find the fundamental solution by using an objective laboratory test and a consumer-centered test to measure and analyze undergarment's comfort in tropical environment.

As opposed to fabric specifications, or just consumers' perception of comfort, this paper gives more comprehensive requirements account for scientific performance of fabric and human perception. This is in this aspect of the textile comfort field and plays emphasis on the fact that the properties of the textile must correspond to the user's expectations. On a more practical level, it offers important information and guidelines for textile manufacturers, designers and product developers when choosing fabric for undergarments which not only have the potential to perform well in the tropical climate but have also been accepted and preferred by consumers.

This research highlights the importance of considering measurable fabric behaviors and wearer sensory experiences when developing products to serve a comfort purpose. This study, from a theoretical point of view, helps to confirm the comprehension of textile comfort as a complex phenomenon that is a function of the feedback between the textile and the person wearing it.

The study shows that comfort assessment is a complex process that cannot be reduced to a sole property of materials, but should be considered as a multidimensional component, influencing and depending on consumer evaluation. In summary, results of this study add support that the measurement of undergarment comfort could be improved by combining laboratory analysis with perception testing with consumers. The results help bring a more user-oriented

approach to developing textiles, specifically for garments to be used in hot, humid, and tropical conditions.

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