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THE INFLUENCE OF DIFFERENT STRUCTURES OF SINGLE-KNIT FABRIC ON THE COMFORT PROPERTIES OF CLOTHES

PENGARUH PERBEDAAN STRUKTUR KAIN RAJUT *SINGLE KNIT* TERHADAP SIFAT KENYAMANAN PAKAIAN

Samuel Martin Pradana[1], Tommy Yacob Hariandja[2], Sukma Yudistira[3], Siti Isma Sari Lubis[4]
[1,3,4] Departemen Ilmu Kesejahteraan Keluarga, Universitas Negeri Padang
[2] Teknik Tekstil Politeknik STTT Bandung
Email: samuelmartinph@fpp.unp.ac.id

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Abstract

This research aims to determine the characteristics of variations in knitted structures on the comfort properties of materials in the form of porosity and moisture management properties in single-knit fabrics. This research was carried out by varying the mesh structure in the form of all knit, knit–knit tuck, and variations of knit tuck–tuck knit, which then looked for the porosity value of the material using the image processing method of thresholding color map images by looking at the size of the space between materials. The air permeability value and the moisture management tester can see moisture management properties in single-knit fabrics. The experimental results found that the porosity test results for structure 1 obtained a porosity value of 22.04%. For Structure 2, it was 29.2%; for Structure 3, it was 30.2% where the test results show that the mesh structure with knit-knit tuck is the best mesh structure with an air permeability value of 735 cm3/cm2/s and an OMMC value of 0.7447.
Keywords: *knitted fabric structure, porosity, moisture management, comfort*

Abstrak

Tujuan dari penelitian ini adalah untuk mengetahui karakteristik dari variasi struktur rajutan terhadap sifat kenyamanan bahan berupa porositas dan sifat *moisture management* pada kain rajut *single knit*. Penelitian ini dikalukan dengan melakukan variasi terhadap struktur jeratan berupa *all knit, knit knit – knit tuck,* dan variasi dari *knit tuck – tuck knit,* yang selanjutnya dicari nilai porositas bahan dengan menggunakan metoda *image processing* gambar citra *tresholding color map* dengan melihat besar nya ukuran dari ruang kosong diantara material. Untuk melihat sifat *moisture management* pada kain rajut *single knitt* dapat dilihat dengan melihat nilai daya tembus udara, dan *moisture management tester*. Dari hasil percobaan didapatkan hasil uji porositas pada struktur 1

didapatkan nilai porositas sebesar 22,04%, pada struktur 2 sebesar 29,2% dan pada struktur 3 sebesar 30,2 %, dimana hasil pengujian menunjukan bahwa struktur jeratan dengan *knit knit-knit tuck* merupakan struktur jeratan yang paling baik dengan nilai daya tembus udara, 735 $cm^3/cm^2/s$, dan nilai OMMC sebesar 0,7447.

***Kata kunci**: struktur kain rajut, porositas, moisture management, kenyamanan*

Introduction

Generally, in daily activities, everyone faces many problems in dressing, such as sweating, feeling hot while running, and improper stretchability, which causes discomfort in its use (Suganthi & Senthilkumar, 2018).

Comfortness is a state of balance between physiological, psychological, and physical with the environment. Physiologically it describes how the body's relationship or interaction responds to the environment. In contrast, psychologically, it describes how a person's ability to think about feeling comfortable and physically describes the relationship between external effects, in this case, the environment, on the human body (Wong & Li, 2006).

To understand the dynamic interaction between the surrounding environment in the physical sphere and the dynamic body can be explained in several processes.

1. Physical processes in clothing and the surrounding environment, for example, heat and moisture transfer in clothing, mechanical interactions between clothing and the body, absorption, and reflection of light by clothing, provide a physical stimulus (or signal) to the body (Lei, 2022).
2. Physiological processes in the body, such as heat balance, namely the thermoregulatory response (heat regulation) and dynamic interactions with clothing and the environment, determine the body's physiological status and ability to survive in critical conditions (Atalie et al., 2022).
3. Neurophysiological processes, neurophysiological mechanisms of the body's sensory reception system on the skin, eyes, and other organs, in which sensory (sense) signals are processed as a result of the interaction of the body with clothing and the surrounding environment (Verlag & Jentzsch-Cuvillier, n.d.).
4. Psychological processes are the processes in which the brain builds subjective perceptions of sensory sensations from neurophysiological signals and then formulates overall subjective perceptions (Karasawa et al., 2022).

Angelova & Velichkova, 2020 said that the property of clothing needed is the property of good comfort. Comfort in clothing can be identified using the term moisture management. Moisture management is the ability of fabrics or clothing to manage moisture (especially sweat) by transferring (or drying) moisture from the skin to the outer surface of the clothing, thereby preventing sweat from wetting the skin surface.

For active use outdoors, clothing must protect itself from the environment, such as wind, sun, and rain. In addition, the clothing must maintain a heat balance between excess heat generated by the wearer due to increased metabolic rate. On the other hand, the clothing must have the capacity to dissipate body heat and good perspiration absorption, as well as rapid cooling and drying.

To get these properties, one way that can be done is to develop the structural design of a material. The structural design development can change through wale per inch (WPI), course per inch (CPI), tension, and cam on the machine. Developing these parts will affect the porosity of the knitted fabric. It is in line with the statement of Imrith et al., 2022

which said that the porosity of the knitted fabric structure would affect its physical properties in the form of density, absorption, mass transfer, and thermal conductivity and by calculating the moisture management capacity in clothing we can determine how much absorption is required. The material can do it, and how fast the absorption time is in it so that it can be classified into materials with good comfort properties.

Method

This research was carried out an experiment that went through three main stages, namely the preparation stage, the implementation stage, and the testing and evaluation stage, wherein the preparatory stage was carried out by preparing the material in the form of 100% polyester yarn with several 150 deniers as many as 30 cones, which were then adjusted to cam diagram on a circular knitting machine. In the implementation stage, the knitting fabric is made on a circular machine by varying the mesh structure into all knit, knit-knit tuck, and knit-tuck knit. In the next stage, testing is carried out on the percent porosity value of the bondage structure using the image processing method of the thresholding color map image by looking at the size of the space between the materials, as well as looking for the comfort properties of the material in the form of air permeability values, and Moisture management tester.

Result and Discussion

Porosity Test with Image Processing

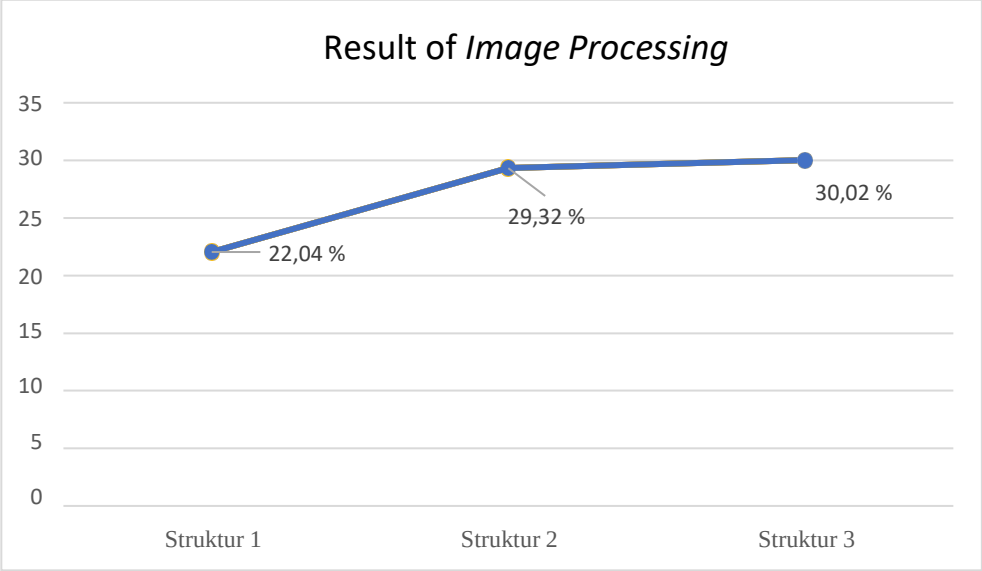

Figure 1. Graph of the relationship between the structure of the knitted fabric and the percent porosity value

Porosity is a measure of the void space between materials and is the fraction of the void volume to the total volume. Porosity can be determined by measuring the total volume of the fabric and calculating the total volume of fibers in the sample. The volume of the unit cell is calculated from the width of the flake, the height of the strip, and the thickness of the fabric, while the volume of yarn occupied in the unit cell is determined from the volume of the material in the unit cell. Porosity can be searched using the image processing method; from the measurement results using image processing from the test

results obtained, the porosity value in structure 1 is 22.04%, structure 2 is 29.32%, and structure 3 is 30.02%. These results show that mesh structures 1, 2, and 3 have different porosity ratios, where the most considerable porosity is found in knit structure 3. Cams with tuck variations do not give a loop effect, so that they will provide higher porosity than knits.

Air Permeability Test

Air permeability is one of the parameters in determining the comfort properties of the material. The test was carried out using a text instrument machine, where the tests were carried out on five different material areas, with an average result on structure 1, namely 693 cm3/cm2/s, on structure 2 obtained a result of 735 cm3/cm2/s, and in structure 3 obtained a result of 607 cm3/cm2/s. From the test results, we can see that the knitted structure affects the air permeability value. The test results show that the knitted structure with the knit-knit tuck structure has the highest air permeability value compared to the knitted structures 1 and 3. This happens because the more significant the porosity, the easier air to circulate. So the more significant the porosity of a material, the better it is at transporting thermal well, thereby providing good comfort properties. From the data from the test results, there are results in structure 1 with an all-knit knit structure (K, K, K, K) providing a fairly high density compared to structure two so that air does not easily circulate properly. In contrast, in Structure 3 with a tuck-knit structure tuck knit (K, T, T, K) which results in an interlocking effect where the fabric is thicker than the test results on structure one and structure two so that air cannot circulate appropriately because of the thickness of the cloth.

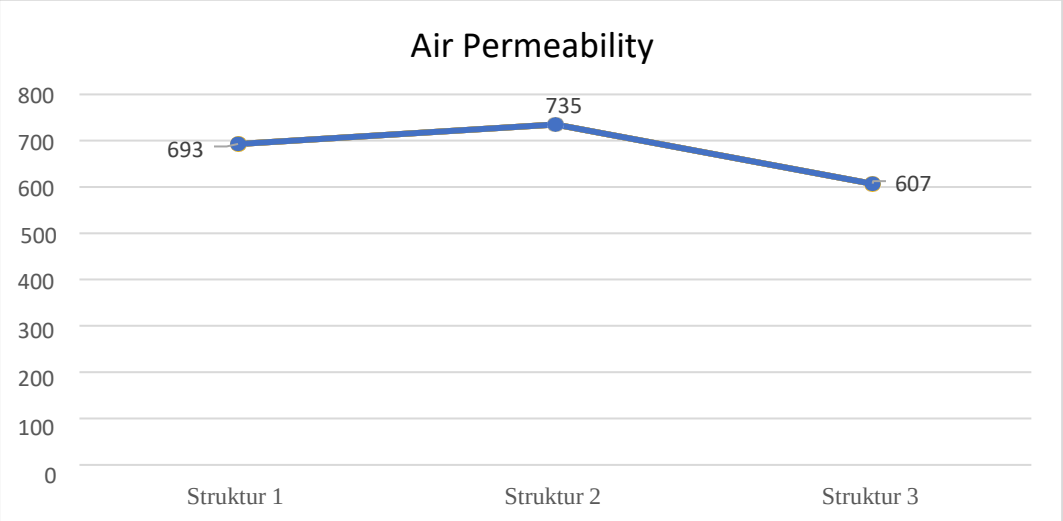

Figure 2. Graph of the relationship between the structure of knitted fabrics and the value of air permeability.

Moisture Management Test

Comfort is one of the clothing attributes in the current era of modernization. Comfort in clothing can be characterized by using a Moisture Management Tester. According to Yao et al., 2006 said in their journal entitled *an improved test methodfor Characterizing the dynamic liquid moisture transfer in porous polymeric materials* in testing moisture management on porous materials, four main points need attention:

Wetting time both on the inside and outside of the fabric surface

1. The ability of the cloth to transport the solution in one direction (one-way transport capability) from the inside of the cloth surface or next to the skin to the outside of the cloth surface or the environment.
2. The speed of spreading wetting is the ability of the cloth to spread the solution from the inside surface of the cloth to the outside of the cloth surface.
3. Furthermore, the last is the test's OMMC value / overall value.

From the results of the tests carried out on the three knitted fabrics with different variations of the mesh structure, the following results were obtained:

Table 1 Moisture Management Tester Values

Sample	Wetting Time Top (sec)	Wetting Time Bottom (sec)	Top Spreading speed (mm/sec)	Bottom Spreading Speed (mm/sec)	Accumulative oneway transport index (%)	OMMC
Sample (1)	1,9282	1,9096	10,5353	10,4408	229,7251	0,7114
Sample (2)	1,8908	1,9472	9,9361	9,6252	242,7944	0,7447
Sample (3)	2,0216	2,1152	8,5334	8,3484	223,3331	0,7214

From the test results, when we compare it to the grade values in Table 1 above, it can be seen that:

Wetting time rate dan one way transport capability

From the results of testing the wetting time on all knitted fabric samples, the results obtained that the wetting time on all test samples was under 3 seconds, which means that all fabrics have a swift wetting time. This happens considering using polyester fiber as an essential material in manufacturing knitted fabrics. As we know, polyester is a synthetic fiber with relatively high crystallinity. Because polyester has a reasonably high crystallinity, when water is dripped onto the fabric's inner surface, the water will be transported directly to the material's outer surface. This is supported by the one-way transport index test results obtained for all fabric samples with values ranging from 200 – 400%, which can be said that the sample can speed up drying.

Spreading Speed

Spreading speed is the accumulated velocity of the spread of the solution from the center of wetting to the maximum distance wetting can occur. Then the ring is estimated to get wet at a particular time. From the results of tests that have been carried out on three types of knitted fabrics with variations in the knitted structure, it shows that knitted fabrics using the all-knit variation provide an excellent spread time speed value with a speed value of 10.4408 mm/sec compared to variations in the knitted structure in sample 2 and 3. This occurs due to the influence of porosity on different materials, where the determining factor in determining the fabric's porosity is the knitted structure itself.

OMMC Score

The OMMC value is an index value used to indicate the overall ability of a fabric to regulate movement or transport a solution or water vapor properly. In their journal, Ullah et al., 2022 state that the greater OMMC value indicates that the material or cloth is very good at transferring solutions or water vapor. From the tests it has carried out on the three types of knit fabrics in the sample, it can be seen clearly that the fabric with the knit-knit tuck structure in sample two has the enormous OMMC value among the other two samples, which is equal to 0.7447 so that it can be said that the fabric with the This is a fabric that is very good at transporting solutions or heat from the body to the environment so that it will provide a sense of comfort to its users.

Conclusion

Based on the results of observations and experiments carried out on circular knitting machines, it can be concluded that the mesh structure of a material will affect the porosity of a cloth, which can be obtained by adjusting the cam on a circular knitting machine and the greater the porosity of material will have an effect on its comfort properties which can be seen by the high value of air permeability and its Moisture management properties, in the form of absorption time, absorption rate, one-way transport capability, and OMMC index value.

References

Angelova, R. A., & Velichkova, R. (2020). The effect of the type of protective suit on the thermophysiological comfort of surgeons in an operating room. *IOP Conference Series: Materials Science and Engineering*, *878*(1), 3–8. https://doi.org/10.1088/1757-899X/878/1/012062

Atalie, D., Gideon, R., Melesse, G., Ferede, E., Getnet, F., & Nibret, A. (2022). Thermo-physiological comfort of half bleached woven fabrics made from different cotton yarns parameters. *Journal of Natural Fibers*, *19*(13), 5034–5049. https://doi.org/10.1080/15440478.2021.1875351

Imrith, M. K., Rosunee, S., & Unmar, R. (2022). Engineering UPF and comfort parameters of knitted fabrics and validation using statistical techniques. *Research Journal of Textile and Apparel*, *December*. https://doi.org/10.1108/RJTA-02-2022-0024

Karasawa, Y., Uemae, M., Yoshida, H., & Kamijo, M. (2022). Prediction of clothing comfort sensation of an undershirt using artificial neural networks with psychophysiological responses as input data. *Textile Research Journal*, *92*(3–4), 330–345. https://doi.org/10.1177/00405175211034242

Lei, Z. (2022). Review of the study of relation between the thermal protection performance and the thermal comfort performance of firefighters' clothing. *Journal of Engineered Fibers and Fabrics*, *17*. https://doi.org/10.1177/15589250211068032

Suganthi, T., & Senthilkumar, P. (2018). Comfort properties of double face knitted fabrics for tennis sportswear. *Indian Journal of Fibre and Textile Research*, *43*(1), 9–19.

Ullah, H. M. K., Lejeune, J., Cayla, A., Monceaux, M., Campagne, C., & Devaux, É.

(2022). A review of noteworthy/major innovations in wearable clothing for thermal and moisture management from material to fabric structure. *Textile Research Journal*, *92*(17–18), 3351–3386. https://doi.org/10.1177/00405175211027799

Verlag, C., & Jentzsch-cuvillier, I. A. (n.d.). *Baye Berhanu Yilma (Autor) A Study on the Effect of Plasma Modification on the Comfort Properties of Polyester / Cotton Blend Fabric*. *49*(0), 0–10.

Wong, A. S. W., & Li, Y. I. (2006). Clothing Biosensory Engineering. In *Clothing Biosensory Engineering*. https://doi.org/10.1533/9781845691462.167

Yao, B. guo, Li, Y., Hu, J. yan, Kwok, Y. lin, & Yeung, K. wing. (2006). An improved test method for characterizing the dynamic liquid moisture transfer in porous polymeric materials. *Polymer Testing*, *25*(5), 677–689. https://doi.org/10.1016/j.polymertesting.2006.03.014