ISSN 2354-0575

RESEARCH ON CHARACTERISTICS OF SOME MATERIALS MAKING UPPER SHOER FOR DIABETICS

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Received: 12/12/2019
Revised: 01/3/2020
Accepted for publication: 20/3/2020

Abstract:

Materials are produced shoes for diabetics must ensuring durability, ventilation, antibacterial, creating a feeling of dryness and air for the feet. The paper presents the results of the research to evaluate the durability and hygiene characteristics (water vapour permeability, absorption and antibacterial activity rate) of 06 material samples used to produce upper shoes that are being been used in our country. Based on ISO 17704: 2004 standard; ISO 17693: 2003; ISO 17706: 2003; ISO 17700: 2004, conducted the characterization of tear strength, abrasion resistance, color fastness, tensile strength, elongation. Water absorption and drainage of elastic shoe lining are determined basing on ISO 17699: 2003 standard. Antibacterial activity rate based on ISO 16187: 2013. The results of the study showed that the durability criteria of the 06 samples of materials were quite high to meet the requirements of shoes. The steam permeability and water absorption of the 06 samples are fairly equal. However, the ratio of antibacterial activity to the difference value, samples 2, 3, 4 billion reached nearly 100%, while samples 1, 5, 6 have antibacterial ability of the material almost not available. Thus, samples 2, 3, 4 are suitable materials for the production of shoe details for diabetics, ensuring the durability and hygiene requirements of the product.

Keywords: *Upper shoes, Upper shoes Material, Diabetic's shoes.*

1. Introduction

The shoe upper is an important detail in contact with the entire instep, which greatly affects the comfort of the shoe: hygroscopic, giving the foot a comfortable, moist heat sensation. Shoes for diabetics, in addition to meeting the hygienic and ecological requirements, must also meet the requirements for smoothness and softness to avoid injury to the feet.

Due to being an important detail, there are many researches on shoe materials and structure in the world to create types of shoes with new features such as anti-cold for feet, antibacterial - deodorant, cure foot disease, monitor user health, increase air circulation inside shoes, insoles shoes for diabetics, etc. [2, 3, 4]. In Vietnam, the footwear industry is relatively young, and research on footwear in general is still limited. Up to now, there have been a number of studies on materials and technology for producing specialized shoes (protective shoes), a number of studies on the hygiene of shoes used in the climate of our country [1], and not much research for shoes material. Therefore, the study evaluates the most important quality criteria of shoe material for patients with foot disease (durability, water vapor permeability, absorption, antibacterial activity) as a basis. The basis for selecting materials and processing high quality shoes is the necessary work.

2. Methods

2.1. Subjects of study

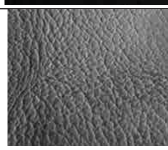
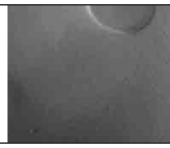
Throughout surveys of shoe brands for domestic and foreign diabetics, shoes manufacturing factory, shoe leather manufacturing and trading company, six types of upper shoes materials are selected to study.

These characteristics of materials are presented in Table 1.

Table 1. Basic characteristics of upper shoe material types

Symbol	Type of Materials	Materials Images	Country of origin	Weight (g/m^2)	Thickness (mm)
M1	3 layers fabric (outside layer is mesh (100% polyester), middle layer is foam, inside layer is knit (cotton + spandex))		Taiwan	350,0	2,79
M2	3 layers fabric (outside layer is knit (Polyester + spandex), middle layer is foam, inside layer is knit (cotton + spandex))		Taiwan	325,0	2,13
M3	Crow Leather (grainy leather)		Viet Nam	1412,01	1,42

Table 2. Basic characteristics of lining upper shoe material types

Symbol	Type of Materials	Materials Images	Country of origin	Weight (g/m^2)	Thickness (mm)
M4	antibacterial Knit (cotton + spandex))		Viet Nam	206,0	0,85
M5	Pig Leather (whey leather)		Viet Nam	805,1	1,10
M6	PU		Taiwan	670,2	1,21

2.2. Contents of study

Study the characteristics of the durability of materials used as shoe details: assessing tear strengthen, abrasion resistance, color fastness, elongation in the warp and weft.

Study the hygienic properties of the materials used as shoe details: focus on researching and evaluating a number of important properties such as water vapor permeability, absorption, antibacterial ability of materials.

2.3. Method of study

Abrasion resistance is determined by ISO 17704:2004 (TCVN 10435:2014): surface resistance shown by an upper test piece when rubbed with an abradant fabric in a Martindale machine, with 51200 rounds. The test is stopped after a prescribed number of cycles and the damage to the specimen is assessed.

Tear strengthen is determined by ISO 17693:2003 (TCVN 9541:2013): Tensile testing machine with a jaw separation rate of 100 mm/min ± 10 mm/min, a force range appropriate to the specimen under test (range of 0 N to 500 N). Experimental tear to the end of the sample in the warp and weft.

Elongation is determined by ISO 17706:2003 (TCVN 10437:2014). Tensile testing machine with a jaw separation rate of 100 mm/min ± 5mm/min, a force range appropriate to the specimen under test (range of 1kN for upper shoes is woven, range of 5kN for upper shoes is leather).

Color fastness is determined by ISO 17700:2004 (TCVN 10948:2015). The test specimen assembly is then sandwiched between two glass surfaces under a 4,5 kg weight and stored in a warm environment for a set time. The specimen and the multifibre fabric are dried separately and the change in their colour is assessed using grey scales.

Water vapor permeability and absorption are determined by ISO 17699:2003 (TCVN 10947:2015).

To assess the water vapor permeability: A circular test specimen is clamped across the open end of a test pot containing a moisture absorbing desiccant. Air of specified humidity and temperature is blown over the test specimen at a set velocity. The air within the pot is circulated by moving the pot which agitates the desiccant. After a measured time the mass of water vapour transmitted through the test specimen is determined and the water vapour permeability of the material calculated. Samples is through 2 time periods: the first time is to to condition the test specimens for 20h ± 4h; the second time is for 11h ± 4,5 h, using the formula:

$$WVP = \frac{M_1 - M_0}{Ax(T_1 - T_0)}$$

where: WVP is water vapor permeability, mg/cm^2.h.
M_0 is the mass recorded in the first time, mg.
M_1 is the mass recorded in the second time, mg.
T_0 is the time recorded in the first time, h.
T_1 is the time recorded in the second time, h.
A is the area of the open end on the pot, cm^2.

To assess the absorption, Either a single circular test specimen or an assembly of circular test specimens which is representative of a completed product or taken from a closed shoe upper, is clamped between an impermeable membrane and the open end of a vertical cylindrical chamber containing a specified volume of water. After a set time for 8h ± 0,1h the mass of water absorbed by the test specimen is measured, using the formula:

$$WVA = \frac{M_1 - M_0}{A}$$

where: WVA là the absorption, mg/cm^2.
M_0 is the mass recorded in the start time, mg.
M_1 is the mass recorded in the finish time, mg.
A is the area of the open end on the pot, cm^2.

Antibacterial ability of materials is determined by ISO 16187:2013 (TCVN 10944:2015), using test method A. Noculating 3 test specimens inoculated and control specimens at (37 ± 2) °C for 24 h. The nutrient medium is agar. Determining the antibacterial ability with Ecoli và Staphylococcus use the formula:

$$R = \frac{T_0 - T_t}{T_0} \times 100\,\%$$

where: R is the antibacterial ability ratio, %
T_0 is the average of colonies of 3 specimens immediately after inoculation, CPU/ml.
T_t is the average of colonies of 3 specimens immediately after inoculation 24h, CPU/ml.
CPU/ml is the number of colony units per ml.

3. Result

3.1. Result of research of upper shoes

Result of the characteristics of 3 materials for upper shoes are presented in Table 3.

Table 3. Result of the characteristics of 3 materials for upper shoes

No	Characteristics		Materials			Standard
			M1	M2	M3	
1	Tear strength	Warp (N)	56,8	56,6	79,3	≥ 40 N Tear strength average
		Weft (N)	131,9	311,7	88,8	
2	Abrasion resistance	Number of cycles	51200	51200	51200	Dry 12800 (not less than the average abrasion level) Wet 6400
		Damage level	No change	Change very little	Change little	
3	Color Fastness	Fade	4-5	4-5	4-5	Color change and color wiring on the outside: Method A: ≥ 3 (gray scale) after 150 dry test cycles and 50 wet test cycles.
		Diaxetat	4-5	4-5	4-5	
		Cotton	4-5	4-5	4-5	
		Polyamit	4-5	4-5	4-5	
		Polyeste	4-5	4-5	4-5	
		Acrylic	4-5	4-5	4-5	
		Wool	4-5	4-5	4-5	
4	Tensile (N)	Warp	192,3	607,1	715,5	≥ 10 N/mm, elongation ≥ 15 % (weft) và ≥ 7 % (warp)
		Weft	209,1	311,7	629,4	
	Elongation (%)	Warp	143,8	83,8	77,4	
		Weft	46,8	232,8	84,7	

According to the data in Table 3, we see: the tear strength in the longitudinal and transverse directions of the 3 samples is ≥ 40 N, ensuring the requirements of upper shoes. Sample 1 and sample 2 have lower longitudinal tear strength than sample 3. However, sample 3 has the lowest tear strength follow weft of 88.8N, while the tear strength value of sample 2 is 311, 7 N is more than 2 times higher than the tear strength of sample 1.

Shoe uppers are places that are greatly affected when people move, impacting on obstacles causing abrasion of materials. However, after 51200 cycles of surface abrasion of the 3 materials studied, there was a slight change. In particular, the surface of sample 1 is intact, with no changes. Thus, 3 samples of materials ensuring abrasion resistance can be used to produce specialized shoes for patients.

Color fastness of 3 samples was assessed on a 5-level gray scale. The results in Table 3 shows that the color fastness of the 3 samples reaches level 4-5, intermediate between level 4 and level 5, there is no significant fading, meeting the requirements of the production of clothing and footwear.

Usually, the size of the foot of the human foot increases slightly in the evening. Shoes should be wider because the feet are edematous [4]. Therefore, the elasticity of the material is also one of the important factors when choosing to produce shoes. The result of the elongation of the 3 materials samples was above the required level. The longitudinal and transverse elongations of the sample 3 were nearly equal to 77, 4% and 84.7%. Meanwhile, the weft elongation was highest, reaching 232.8%, nearly 3 times higher than that of sample 3 and 5 times higher than that of sample 1. However, the elongation of sample 1 was highest, reaching 143, 8%, nearly 2 times the warp elongation of sample 2 and 3.

Materials for the production of shoes for diabetics must be well ventilated and well ventilated - the ability for air, water and steam to pass. Removing moisture from the foot of sweat to the outside environment creates a feeling of dryness and air for the feet.

Figure 1 shows that water vapor permeability and absorption of the three samples of shoe material are approximately equal, reaching about 15 mg/ cm^2.h; 100 mg/cm^2, 7 times higher than required.

The climate in Vietnam is hot, humid. Therefore, shoes for users, especially for those with foot disease, should minimize the effect of bacteria that cause bad breath and can cause increased foot disease. The results on Figure 2 only show that the ratio of antibacterial activity to the two strains of ecoli and Staphylococcus-aureus of sample 2 reaches 100%, the highest of the 3 material samples. Sample 1 has the lowest bacterial activity rate.

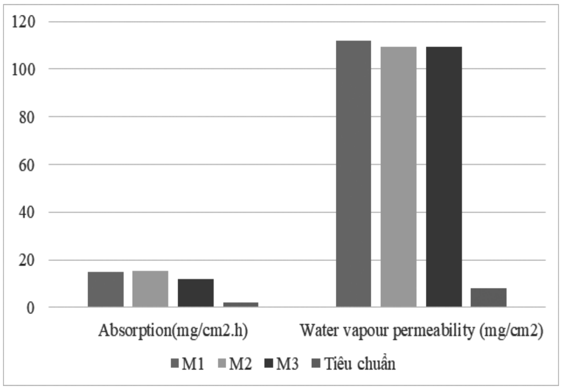


Fig 1. Compare the water vapor permeability and absorption of the three upper shoes materials

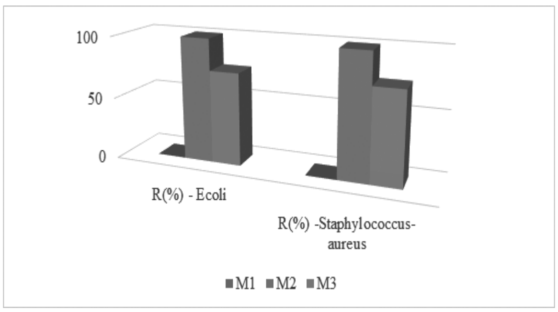


Fig 2. Compare the antibacterial ability ratio (R) of the three samples of upper shoes materials

3.2. Result of research of lining upper shoes

Result of the characteristics of 3 materials for lining upper shoes are presented in Table 4.

Lining upper shoes is the friction position between the instep of a person and the surface of the material. After 51200 cycles of surface abrasion of 3 samples were changed slightly. In particular, the sample surface 6 ensures almost intact, the change is very light. Thus, 3 material samples with satisfactory abrasion resistance.

Table 4. Result of the characteristics of 3 materials for lining upper shoes

TNo	Characteristics			Result			Standard
				M4	M5	M6	
1	Color Fastness	Fade		4-5	4	4-5	Method A Color wiring ≥ 3 (Grey scales) after 50 cycles with sweat solution
		Color wiring	Diaxetat	4-5	4-5	4-5	
			Cotton	4-5	4	4-5	
			Polyamit	4-5	3	4-5	
			Polyeste	4-5	4-5	4-5	
			Acrylic	4-5	4-5	4-5	
			Wool	4-5	3-4	4-5	
2	Abrasion resistance	Number of cycles		51200	51200	51200	Dry 25600 Wet 12800 There are no holes on the entire thickness of the material part
		Damage level		Change little	Change little	Change very little	
3	Absorption (mg/cm^2.h)			16,4	15,0	7,5	WVP ≥ 2.0 mg/cm^2.h If WVP of upper shoes < 0.8 mg/cm^2.h so WPA of lining upper shoes ≥ 8.0 mg/cm^2
	Water vapor permeability (mg/cm^2)			121,9	111,8	35,7	
4	Resistance with sweat	Change appearance		No change	No change	No change	After 5 cycles, the lining upper shoes must be free of any cracks when bending
		Change dimension	Warp	-5,0	-5,5	-4,2	
			Weft	-6,0	-4,5	-0,5	

The data in Table 4 show that the color fastness of samples 4 and 6 reaches grade 4-5 when in contact with materials with different components. Particularly, 3 materials when in contact with polyamit, color fastness reaches grade 3. Thus, all samples ensure the requirements of the production of clothing and footwear. The water vapour permeability, absorption, sweat resistance of 3 samples of lining upper shoes give different values. Sample 6 has the lowest water vapour permeability and absorption only 7.5 mg/cm^2.h; 35.7 mg/cm^2. Sample 4 and sample 5 have the same water vapour permeability and absorption. However, all 3 types of materials are guaranteed.

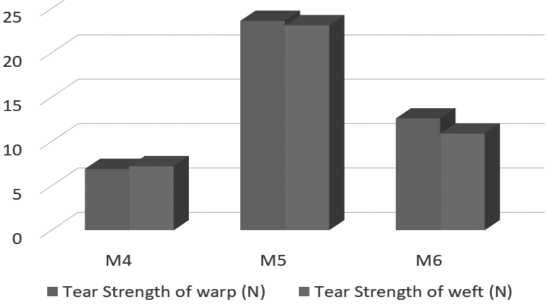


Fig 3. Tear Strength of warp and Tear Strength of weft of 3 materials for lining upper shoes

According to the data in Figure 3, we see: the tear strength in the warp and weft of the 3 material samples is very different. Sample 4 has the same tear strength in both warp and weft, reaching 6.9 N and 7.2 N. Sample 5 has the greatest vertical and horizontal tear strength, which is 2 times higher than the vertical and horizontal tear strength of sample 6, reaching 23,6 N and 23,1 N.

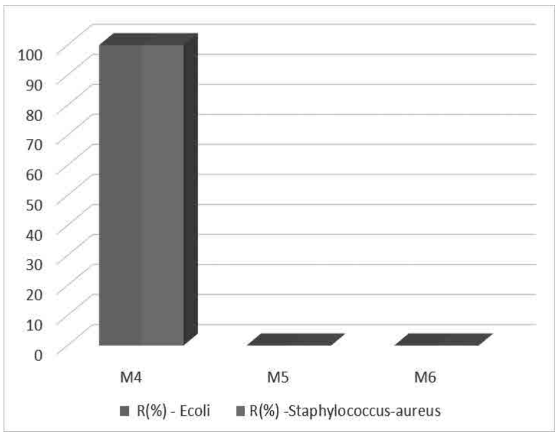


Fig 4. Compare the antibacterial ability ratio (R) of the three samples of lining upper shoes materials.

Lining upper shoes is the part that direct contact with the human foot when used. This is an important part that contributes to the protection of the patient's feet. The data on Figure 4 shows that the ratio of antibacterial activity to 2 strains of ecoli and Staphylococcus-aureus of sample 4 reached 100%, the highest of the 3 material samples. Samples 5 and 6 have the same bacteriostatic activity, almost no antibacterial.

4. Conclusion

Shoe uppers are important details that greatly affect shoe comfort. Research results show that leather materials, knitted materials, leatherette materials all meet the requirements of durability, color fastness, water vapor permeability and water absorption. In particular, the weft elongation of the sample 2 reached 232.8%, nearly 3 times the sample 3 and 5 times the sample 1. The water vapor permeability and moisture absorption of 6 samples reached a fairly high value and copper are. However, the antibacterial activity rate for the difference value, this sample 2, sample 3, sample 4 billion reached nearly 100%, while samples 1, 5, 6 have antibacterial ability of the material almost not available. As such, samples 2, 3, 4 are suitable materials for the production of shoe details for diabetics, ensuring the durability and hygiene requirements of the product. These materials have different durability and hygiene characteristics, so they should be used in combination with high-strength outside materials and lining materials with high ventilation and antibacterial..

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NGHIÊN CỨU ĐẶC TRƯNG TÍNH CHẤT CỦA MỘT SỐ VẬT LIỆU LÀM CHI TIẾT MŨ GIẦY CHO BỆNH NHÂN ĐÁI THÁO ĐƯỜNG

Tóm tắt:

Vật liệu sản xuất giầy cho bệnh nhân tiểu đường phải đảm bảo độ bền, thông hơi, kháng khuẩn, tạo cảm giác khô thoáng cho bàn chân. Bài báo trình bày kết quả nghiên cứu đánh giá các đặc trưng độ bền và tính vệ sinh (độ thẩm hơi nước, hấp thụ hơi nước và tỷ lệ hoạt tính kháng khuẩn) của 06 mẫu vật liệu sử dụng sản xuất chi tiết mũ giầy tiêu biểu đang được sử dụng ở nước ta. Trên cơ sở tiêu chuẩn ISO 17704:2004; ISO 17693:2003; ISO 17706:2003; ISO 17700:2004, đã tiến hành đánh giá đặc trưng độ bền xé, độ bền mài mòn, độ bền màu, độ bền kéo, độ giãn. Độ hút nước và thải nước của lót giầy đàn hồi được xác định trên cơ sở tiêu chuẩn ISO 17699:2003. Hoạt tính kháng khuẩn được thực hiện theo tiêu chuẩn ISO 16187:2013. Kết quả nghiên cứu cho thấy: các chỉ tiêu độ bền của 6 mẫu vật liệu đều đạt giá trị khá cao đảm bảo yêu cầu của giầy. Độ thẩm hơi nước và hấp thụ hơi nước của 6 mẫu khá đồng đều. Tuy nhiên, tỷ lệ hoạt tính kháng khuẩn cho giá trị khác biệt, mẫu 2, mẫu 3, mẫu 4 tỷ này đạt gần 100%, trong khi đó mẫu 1, mẫu 5, mẫu 6 khả năng kháng khuẩn của vật liệu gần như không có. Như vậy, mẫu 2, mẫu 3, mẫu 4 là vật liệu phù hợp với việc sản xuất chi tiết mũ giầy cho bệnh nhân tiểu đường, đảm bảo yêu cầu về độ bền và tính vệ sinh của sản phẩm.

Từ khóa: *Mũ giầy, Vật liệu mũ giầy, Giầy tiểu đường.*