Egyptian Journal of Chemistry
http://ejchem.journals.ekb.eg/

Improve the Efficiency of Fabrics Performance to the Services Workers (Cleanliness) According to Nature of Their Job

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CLOTHES play an important role in healthy life, workers is concern on comfort, especially cleanliness workers, whose needs to efficiency in performance of their work. The main aim of this research is improving the efficiency of Fabric performance of cleanliness workers by produce fabrics with using natural fibers that will provide good comfort properties. The influence of fabric factors such as, kind of fibers, weft density and weaves structure on the fabrics properties as weight, thickness, air permeability, water absorbency, strength, abrasion resistance was determined. The results show that, the best sample achieved the best performance on use bamboo 100%, fabric structure twill 1/3, and set 40 weft / cm.

Keywords: Air permeability, Clothing comfort, Fabrics performance, Services workers, Water absorbency.

Introduction

Clothing plays a significant role in human's life, and it has a vital role in achieving comfort [1,2]. Clothing comfort is usually measured through the interaction between human body and its surrounding climate [3]. All types of clothing need to have a balance of properties: aesthetic, protective, and economics [4]. We must consider that specification takes place on the basis of functionality. In that case, we should not focus on the cost fundamentally at the expense of comfort [5].

Functional requirements of clothing for service workers

Service workers operate in a range of different working and weather conditions. Outdoor working conditions require durable fabrics that provide protection against a range of risks, to confront chemical and bad weather conditions [5].

It is not difficult to achieve good quality fabrics for service workers, but the technical problems arises mainly because of the need to combine the comfort with protection and economics; therefore, compromise is needed to achieve acceptable fabric for work wear [6].

The following is an explanation of the most important characteristics required for service workers' clothes.

Fabric handle

Fabric handle is one of the terms used in describing clothing comfort performance by consumers [4]. It is concerned with the subjective judgment of roughness, smoothness, harshness, pliability, thickness, etc.

Air permeability

Air permeability is defined as the rate of air flow through the fabric when there is a different air pressure on the surfaces of the fabric [7]. It plays a significant role in transporting moisture vapors from the skin to the outside atmosphere [8]. The most important indicator for comfort is air permeability, as the air penetration through clothing increases body cooling [4].

It should be noted that the moisture-vapor permeability and the liquid moisture transmission are normally related by air permeability [8]. The main factors influencing it are fabric porosity, fabric thickness, and raw materials. Fabrics with loose structure have better air permeability [1, 2].

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Received 16/6/2019; Accepted 18/7/2019
DOI: 10.21608/ejchem.2019.13716.1848

Moisture absorption

Moisture into the clothing occurs internally owing to sweating. Evaporative moisture from a human is half a liter per day (about 30 g/h). Moisture in textile material decreases thermal insulation [5]. There is a general agreement that moisture transmission through textiles has a great influence on the thermophysiological comfort of the human body [8]. Heat and moisture transfer occurs through pores of textile, fiber and surface, and capillaries between fibers, yarns, and fabric [9].

Water vapor permeability

The human body modifies its temperature by sweat production and evaporation during the periods of high activity. The clothing must be able to remove this moisture to maintain comfort and reduce the thermal insulation caused by moisture build-up. A breathable textile allows extra heat loss by evaporation of moisture through the clothing layers. So, breathability is very important to increase the efficiency of the fabric to allow water vapor to reach the ambient air [4,10];

Thermal insulation

Thermal insulation of fabric is dependent on the shape of fiber cross- section, fiber content, and yarn structure. When the yarn linear density is increased, thermal conductivity is decreased because the fibers trap more air [7].

Comfort

Comfort is a pleasant state of physiological, psychological, and physical harmony between a human being and the environment [4,8,11]. Discomfort mainly results from the build-up of sweat on the skin during overheating [11,12]. So clothing must be designed to allow the body's heat balance to be maintained under different environmental conditions and body activity.

Comfort of fabrics mainly depends on the construction of the fabrics; there are specific textile properties that may be measured to predict the comfort performance of fabric, such as weight, thickness, thermal insulation, evaporation, and air permeability [3,8,13]. There, the design of clothing must have a balance between design requirements and function, performance, protection, and comfort [6,14].

Antimicrobial

Natural fibers are prone to microorganism colonization owing to their moisture retention ability. Microorganisms cause undesirable effects on the textile and the user. Many different natural and synthetic compounds have been developed to impart antimicrobial properties to textiles. Any antimicrobial treatment must be also non-toxic to the consumer and to the environment [2,15].

Self-cleaning textiles

The self-cleaning theory was discovered from the natural phenomenon noticed on the leaves of a lotus plant [15–17]. The main factors contributing toward increasing demand on the self-cleaning textiles are high consumption of energy, usage of excessive water, and usage of chemical detergents for cleaning clothes which affects the environment. Moreover, self-cleaning garments possess excellent ultraviolet protection property [6].

Factors influencing fabric behavior

Fiber type

Textile material is the most important parameter that determines the comfort of clothes. Comfort is basically dependent on the chemical structure and morphology of the fibers, where liquid moisture transport in textile materials is affected by the moisture of the fiber content [2,3,6]. Man-made fibers cannot overcome the natural fibers in comfort properties, although they are low cost and have good mechanical and chemical properties. Blending the fibers in a fabric can improve the properties and reduce cost of garments [4, 13, 18].

Bamboo fiber is a material that has many characteristics that meet the requirement of the end user. It is ecofriendly, biodegradable, antibacterial (even after being washed 50 times), and antifungal; has good resistant to ultraviolet [2,8,10]; and also has strong durability, stability, and tenacity, in addition to its high moisture absorption capacity, breath-ability, and fast drying behavior owing to its unique microstructure [7,12].

Yarn parameters

Increases in yarn fineness, yarn twist, and a less density structure improve the air permeability of the fabric, increase water vapor permeability, and produce lower thermal resistance, as well as cooler feeling. When the yarn count is coarser, the fabric density and its thickness are increased, so water vapor permeability is lower [4,7].

Fabric structures

Fabric construction affects the thermal comfort properties of woven fabrics [10]. Its thickness influences the heat and moisture transfer, because it affects the air and moisture permeability, hence influence on thermal comfort. Textile structure also improves the insulation value of the textile by increasing air in it, so air has been considered as a vital factor affecting heat and moisture transfer.

The major properties that affect are fabric density, porosity (the pores facilitate heat and moisture transfer, for better ventilation), bulkiness, thickness, structure, and pattern. The fabric pattern creates its thickness and weight properties; on the contrary, it determines the air and liquid permeability and thermal insulation. Twill structure is smoother than plain structure and has higher fullness, softness, and compressibility [4]. The authors reported that tighter fabrics were less comfortable [7].

Materials and Methods

Specification of samples under study

To improve the efficiency of fabric performance for service workers, 12 samples were produced, as listed in Table 1. The warp material for all samples was cotton. Its yarn count was 40/2 Ne and warp density was 36/cm. The weft material was bamboo 100% and a blend of 70% bamboo/30% cotton. Yarn count for bamboo and bamboo/cotton blend was 30 NE; wefts densities were 48 and 40 picks/cm, respectively; and structure was twill 2/2, twill 1/3, and basket 2/2.

TABLE 1. The specifications of produced samples.

No	Property	Specification
1	Warp type	Cotton
2	Count of warp yarns	40/2 Ne
3	Warp set (ends / cm)	36 / cm
5	Count of weft yarns	30 Ne
6	Weft type	bamboo 100% and blend , 70 bamboo / 30cotton
7	Weft set (picks / cm)	40 – 48 picks/cm
8	Fabric structures	basket 2/2, twill 2/2 and twill 1/3

Test applied for samples under study

The experimental tests have been achieved in the weave laboratory in the National Research Center, in a standard environment (relative moisture: 65±2, temperature 20°C±2). To evaluate the performance properties of the produced samples, the following tests were carried out:

(1) Fabric weight.

(2) Fabric thickness.

(3) Fabric air permeability.

(4) Fabric absorbs water.

(5) Fabric tensile strength and elongation.

(6) Fabric abrasion resistance.

Results and Discussion

Results of the experimental tests carried out on samples under study are presented in the following tables and graphs. Results were also statistically analyzed for data listed, and relationships between variables were obtained.

Effect of material and structure on fabric properties

Effect of material and structure on fabric weight and thickness

It is clear from Table 2 and Fig. 1 that blend weft has the highest weight, whereas bamboo has the lowest weight for all structure, which may be owing to the density of cotton is higher than the density of bamboo, so its weight is higher. On the contrary, Fig. 2 shows that the thickness of weft bamboo 100% is equal or slightly higher than blend weft.

There is an insignificant correlation between the weight and thickness of the fabrics and the type of raw material used, or the textile structures,

Effect of material and structure on air permeability and absorbed water of fabrics

Table 2 and Fig. 3 show that the highest air permeability was in fabrics that used 100% bamboo weft, followed by fabrics that used blended cotton and bamboo in weft. This may be owing to the gaps or distances between fibers in the bamboo 100% are greater than mixed yarn, because the cross-section of bamboo fibers are irregular, so they allow for a larger size of the gaps in the thread, thus increasing the amount of air passing through it. Twill 1/3 has recorded insignificant increase in air permeability owing to the equal size approximately of the blanks for both basket 2/2 and twill 2/2 with a slight increase for twill 1/3.

TABLE 2. Samples specification and test results.

Material	Structure	Set/cm	Weight gm/m^2	Thickness mm	Air permeability $cm^3/cm^2/sec$	Absorb water %	Width tensile kg	Width elongation %	Length tensile kg	Length elongation %	Abrasion resistance %
Bamboo	basket 2/2	40	222.3	40.50	3	21.5	99.33	31.33	160	21	10
Bamboo	twill 1/3	40	222.7	42.00	3.7	18.71	98.67	27.67	157.33	23.33	14.63
Bamboo	twill 2/2	40	234.7	39.50	2.81	23.03	97	27.33	157.33	21.33	12.5
Blend bamboo& cotton	basket 2/2	40	223.7	41.00	2.01	18.55	88.67	25	160	19.33	7.69
Blend bamboo& cotton	twill 1/3	40	227	40.50	2.48	11.21	90	24	158	23	9.76
Blend bamboo& cotton	twill 2/2	40	232	39.75	2.24	18.68	90	22.67	149.33	24	10.26
Bamboo	basket 2/2	48	208.3	37.50	4.41	19.88	87	26	145.33	20	12.82
Bamboo	twill 1/3	48	211.3	41.25	5.37	30.48	87.33	29.33	143.33	20.67	12.2
Bamboo	twill 2/2	48	207	41.00	5.13	27.51	77.33	27.67	156.67	20	12.82
Blend bamboo& cotton	basket 2/2	48	208.7	37.25	4.87	18.25	76.67	25	149.33	20.33	10.53
Blend bamboo& cotton	twill 1/3	48	214.7	40.00	5.4	15.93	73.67	24.33	152.67	22	12.5
Blend bamboo& cotton	twill 2/2	48	213.3	40.50	5.01	24.37	75.33	21.67	155.33	20.67	13.16

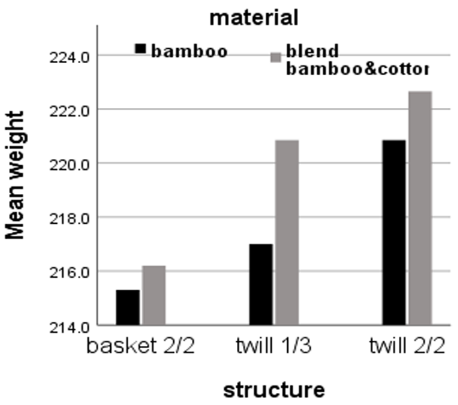

Fig. 1. Effect of material and structure on weight (gm/m²).

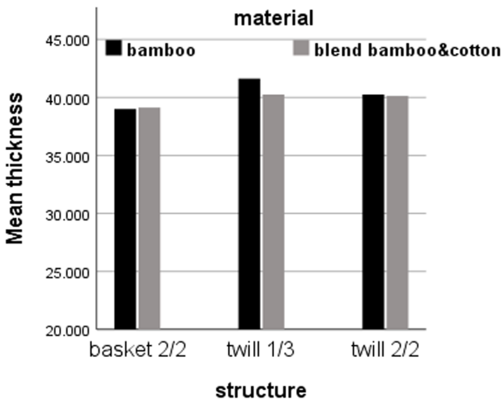

Fig. 2. Effect of material and structure on thickness (mm).

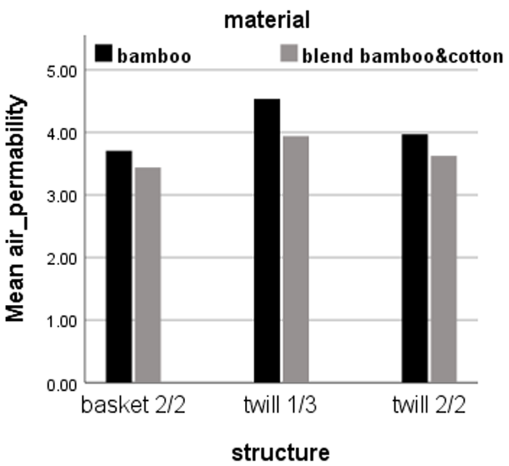

Fig. 3. Effect of material and structure on air permeability (cm3/ cm2/ sec).

Figure 4 shows that water absorption in fabrics that used 100% bamboo weft is higher than water absorption in bamboo fabrics mixed with cotton. This is owing to the ability of bamboo to absorb moisture higher than cotton, and thus will make the clothes more comfortable than the cotton clothes. The textile structure did not have any significant effect on the moisture absorption ratio.

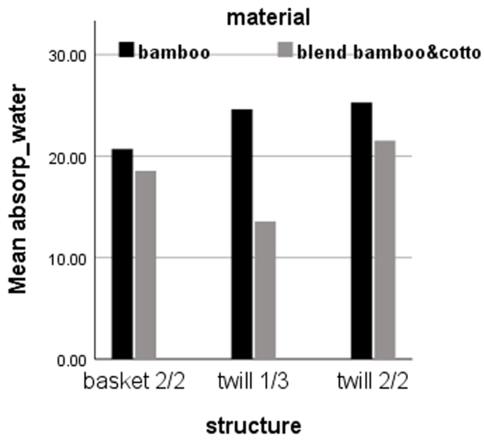

Fig. 4. Effect of material and structure on absorb water (%).

Effect of material and structure on warp tensile strength and elongation

Table 2 and Fig. 5 and 6 show that the tensile strength and elongation of the samples under study in the direction of warp were almost equal, and there was no difference between them, where the warp was cotton material for all the samples. Moreover, the intersection of textile structure used was almost equal to all textile structures.

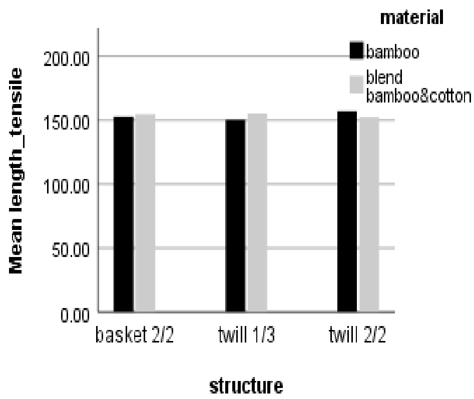

Fig. 5. Effect of material and structure on warp tensile strength (kg).

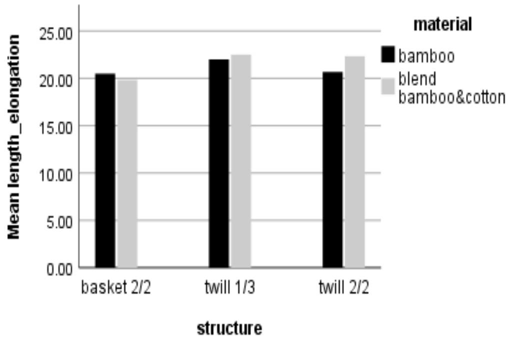

Fig. 6. Effect of material and structure on warp elongation (%).

Effect of material and structure on weft tensile strength and elongation

Table 2 and Fig. 7 and 8 show that the tensile strength and elongation of the samples under study in weft direction were higher in the weft bamboo 100% than that mixed with the cotton. This may be owing to the irregular cross-sectional of the bamboo fibers, which allows more overlap and friction between the filaments, increasing the strength of threading and therefore cloth.

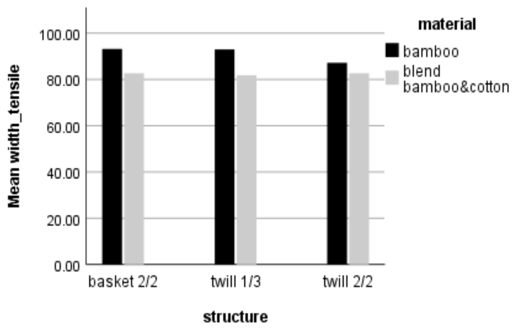

Fig. 7. Effect of material and structure on weft tensile strength (kg).

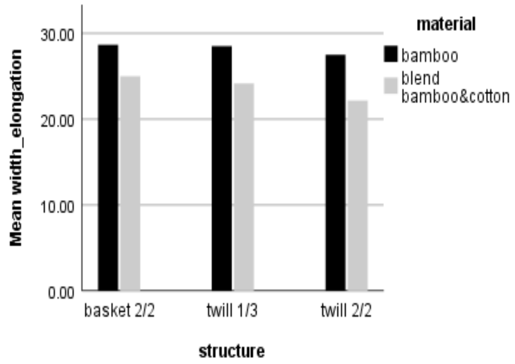

Fig. 8. Effect of material and structure on weft elongation (%).

Effect of material and structure on abrasion resistance

Table 2 and Fig. 9 show that fabrics that use weft 100% bamboo have higher resistance to friction from fabrics that use weft blend bamboo and cotton. This is because bamboo 100% is stronger and more durable than bamboo mixed with cotton, as show from Fig. 7.

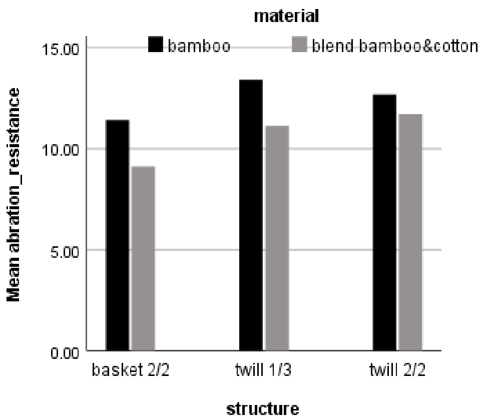

Fig. 9. Effect of material and structure on abrasion resistance (Loss of thickness).

As shown in Fig. 9, twill structure 1/3 in weft bamboo 100% achieved the highest friction resistance, follow by twill 2/2, and in the last, was basket 2/2, but the differences between them are not significant (0.167)

Effect of weft set on fabric properties

Effect of weft set on weight and thickness

Table 2 and Fig. 10 show that there is a strong significant correlation between the number of weft/cm and the weight of the square meter of fabric (0.9), which means the higher number of weft/cm, the higher weight per square meter of fabrics for each of the bamboo and blended yarn.

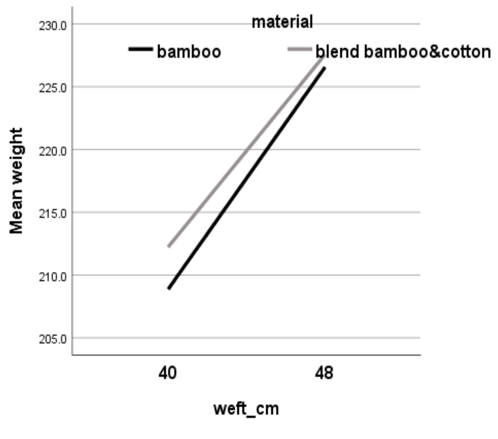

Fig. 10. Effect of Weft set on Weight (gm/m^2).

However, Table 2 and Fig. 11 show that there is an inverse correlation between the number of weft/cm and the thickness of the fabrics (-0.4), which means the greater the number of weft, the less the thickness of the fabrics, owing to increasing the integration of the fabric, so the thickness of the fabric is less.

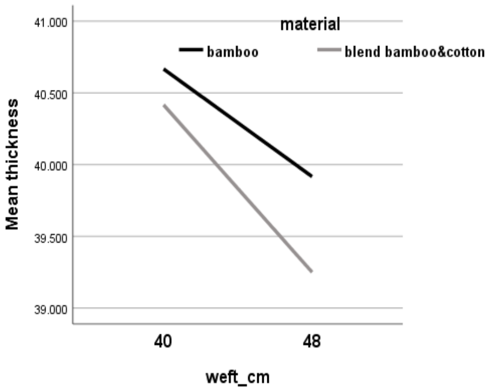

Fig. 11. Effect of Weft set on thickness (mm).

Effect of weft set on air permeability and absorbing water

Table 2 and Fig. 12 show that there is a strong inverse correlation between the number of weft yarn and air permeability of fabric (-0.9), meaning that the higher number of weft/cm leads to less fabric air permeability for the bamboo 100% and blend weft, which is owing to the reduced gap spaces area in the fabric, thus reducing air permeability of fabric.

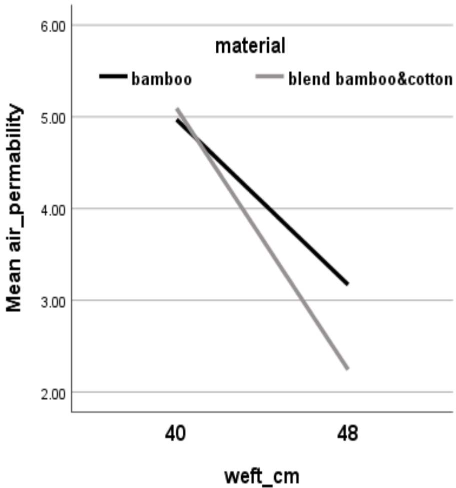

Fig. 12. Effect of Weft set on air permeability ($cm^3/cm^2/sec$).

Moreover, Table 2 and Fig. 13 show that there is an average inverse correlation between the number of weft and the percentage of moisture absorption for each of the bamboo and mixed materials (-0.4). This is owing to that the main factor influencing the absorbed moisture is the type of material used not the number of weft.

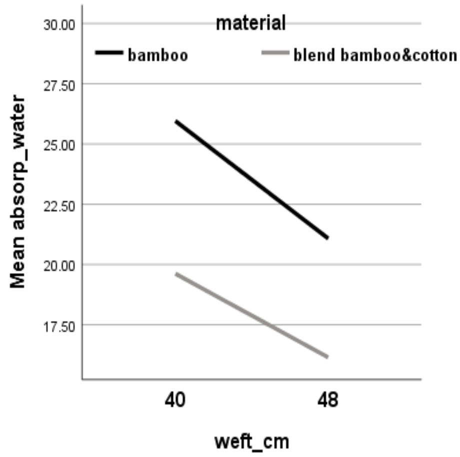

Fig. 13. Effect of Weft set on water absorb (%).

Effect of weft set on tensile strength and elongation of weft

Table 2 and Fig. 14 show that there is a strong significant correlation between the number of weft and tensile strength of the fabric in the direction of the weft for both bamboo 100% and blend (0.8). This means the higher number of weft/cm leads to stronger the fabric in the direction of the weft for bamboo and blend, which is logical. In the case of elongation, it was also increased (Fig. 15), but this increase is insignificant (0.1).

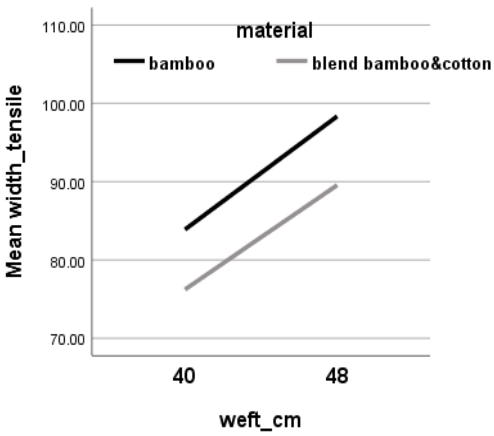

Fig. 14. Effect of Weft set on tensile strength of weft (kg).

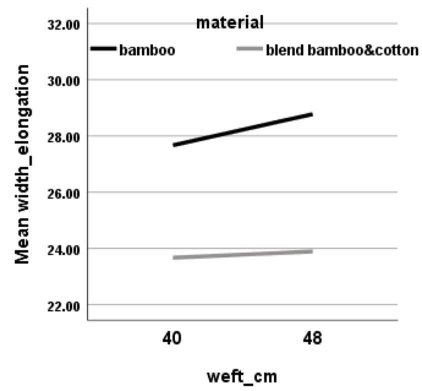

Fig. 15. Effect of Weft set on elongation of Weft (%).

Effect of weft set on tensile strength and elongation of warp

It is clear from Table 2 and Fig. 16 and 17 that there is a significant average correlation between the number of weft and tensile strength of the fabric in warp direction for both bamboo 100% and blend (0.6). This means the higher number of weft/cm leads to stronger fabric in the direction of the warp. Moreover, there is increased elongation with the increase in the number of weft (0.4). This is owing to the increase in the percentage of crimp in the thread.

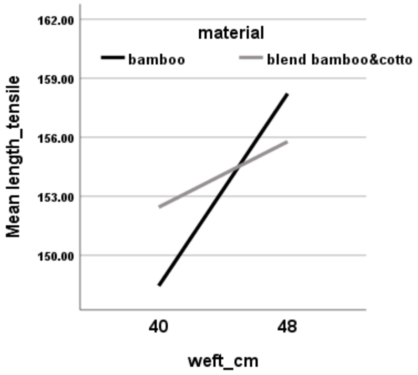

Fig. 16. Effect of Weft set on tensile strength of warp (kg).

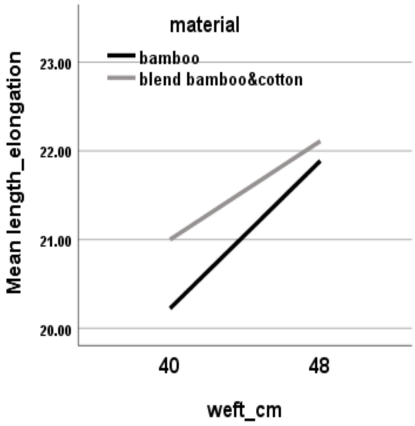

Fig. 17. Effect of Weft set on elongation of warp (%).

Effect of weft set on abrasion resistance

It is clear from Table 2 and Fig. 18 that there is an average correlation between the number of weft per cm and abrasion resistance of fabrics, but this correlation is insignificant (0.4). It is clear also that weft 100%bamboo was more durable and abrasion resistant than blend yarn from bamboo and cotton, and this is owing to that bamboo has more strength and is more durable.

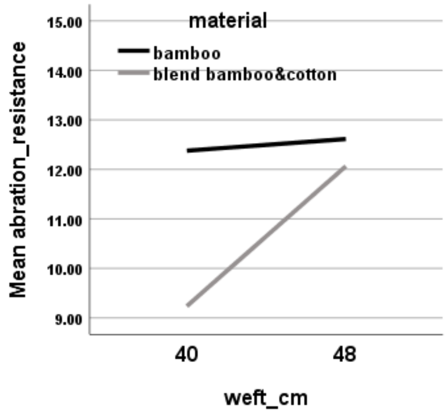

Fig. 18. Effect of Weft set on abrasion resistance (Loss of thickness %).

Determine the best sample giving the highest efficiency when used

It is clear from the radar charts from Figs 19–22 that the best sample that achieved the best performance on use was the sample using weft bamboo 100%, fabric structure twill 1/3, and set 40 weft/cm, with an area of 8.60 cm2. This sample in addition has many advantages: it is resistant to bacteria, as well as resistant to dirt. This was followed with not big difference that sample which had blended weft, twill 1/3, and set 48 weft/cm, with an area of 8.35 cm2. However, this is distinguished by being cheaper than bamboo 100%, as the bamboo is not grown in Egypt, but is imported from abroad.

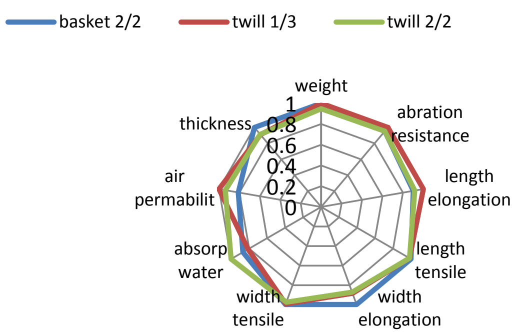

Fig. 19. Shows the radar charts of the bamboo 100% using 48 weft / cm.

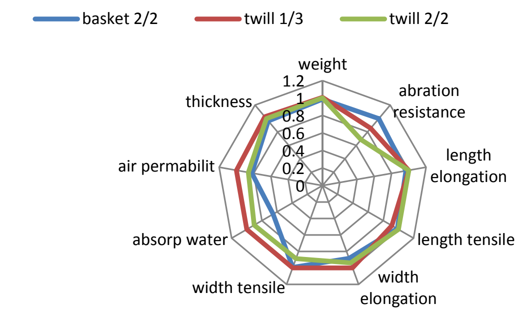

Fig. 20. Shows the radar charts of the bamboo 100% using 40 weft / cm.

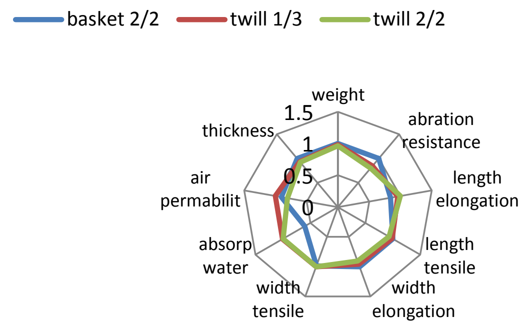

Fig. 21. Shows the radar charts of the blend bamboo using 48 weft / cm.

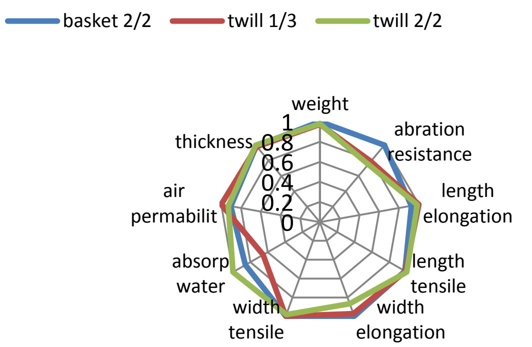

Fig. 22. Shows the radar charts of the blend bamboo using 40 weft / cm.

Conclusion

The main aim of the research studies in the textile and apparel industry is to improve the life quality of the people and improve occupational safety and health. Clothing physiology is the interaction of clothing and human body in various environments [9]. Comfort is obtained by materials with special properties such as bamboo. Bamboo fabrics has many positive properties such as softness, which provides comfortable wear for the users; absorption of water; ventilation, which keeps air circulated and provides breathability; and anti-bacterial, stinking, and ultraviolet-resistant properties, which protects the user from skin diseases. The best sample achieved the best performance on use was bamboo 100%, fabric structure twill 1/3, and set 40 weft/cm. Bamboo clothing provides healthy properties for the users and friendly properties to the environment. It is also possible to use the mixture weft from bamboo 70% and cotton 30% with respect to economic aspects, as the bamboo does not grow in Egypt.

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تحسين كفاءة أداء أقمشه عمال الخدمات (النظافة) بما يتلائم مع طبيعة وظيفتهم

علا عبد السلام بركات، هبة خميس عبد التواب
قسم الغزل والنسيج والتريكو- جامعة حلوان - القاهرة - مصر.

الهدف الرئيسي من هذا البحث هو تحسين كفاءة أداء أقمشة ملابس عمال الخدمات (عمال النظافة)، من خلال إنتاج الأقمشة باستخدام خامات طبيعية توفر لهم خصائص راحة جيدة تساعدهم علي إنجاز أعمالهم في الأجواء والظروف البيئية المختلفة في جو من الرضى والأرتياح النفسي والجسدي. تم إنتاج 12 عينة مستخدما بها في اللحمات خامة البامبو 100%، وبامبو مخلوط مع القطن بنسبة 70% : 30% علي التوالي، كما إستخدم عدتين للحمة 40لحمة/سم، 48 لحمة/ سم، أيضا إستخدمت 3 تراكيب نسجية سن ممتد كلا الأتجاهين 2/2 ، ومبرد 2/2 , ومبرد3/1 . وقد أجري علي هذة العينات إختبار كل من: الوزن، السمك، نفاذية الهواء، إمتصاص الماء، قوة شد وإستطالة كل من السداء واللحمة، مقاومة الأحتكاك.

الأقمشة المصنعة من البامبو 100% لها العديد من الخصائص المميزة مثل نعومة الملمس وبالتالي تعطي شعور بالراحة للمستخدمين، هذا بالإضافة إلي امتصاصها للرطوبة، والتهوية الجيدة وبذلك فهي تحمي المستخدم من الأصابة بالأمراض الجلدية، أيضا لها خصائص مضادة للبكتيريا والروائح الكريهة وخصائص مقاومة للأشعة فوق البنفسجية. وقد حققت عينة البامبو100% مع عدة لحمة 40لحمة/سم، وتركيب نسجي مبرد 3/1 أفضل عينة. وجاء بالمرتبة الثانية البامبو المخلوط مع القطن، وعدة 48لحمة /سم، وتركيب نسجي مبرد 3/1، ومن أهم مايميز هذه العينة أنها أرخص سعرا لأن البامبو لا ينمو في مصر وإنما يستورد من الخارج. وجدير بالذكر أن الملابس البامبو بالإضافة إلى أنه تعطي خصائص صحية للمستخدمين فهي أيضا لها خصائص صديقة للبيئة.