Design and production of technical textile to reduce the expansion of bacterial contagion in spawning laboratories and poultry farms

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Abstract:

Poultry farming is one of the most important industries in Egypt which needs huge number of labors (Hermans, 2012). Approximately three million persons work in this industry. The technical Textiles which used in the poultry farming should be suitable for the hard circumstances of work (Sullivan, 2012). Mechanical properties of these garments must be considered to catch high durability during using. Fabrics advantage parameters are often depended on their mechanical properties (Koyuncu, 2016). In this paper we produce various types of fabrics which can be used as labor garments in the poultry farms by using the Rapier weaving loom.in this paper we used three types of different materials and different types of constructions. Tests were carried out for different types of fabric materials and constructions, cotton, bamboo and polyester. Mechanical properties of fabrics are tested, Tear and Tensile strength has the principal consequence and weave modification has a considerable effect. The effect of a weave construction on the strength of the fabric is evaluated in this research.

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These results are submitted in this paper with statistics value tables and graphs.

Keywords:

Poultry industry; Technical textile; Bamboo material; Cotton material; Sustainable material.

(1) Introduction:

Poultry have been on the earth for over 150 million years, world poultry meat production soared from 9 to 133 million tons between 1961 and 2020, and egg production shot up from 15 to 93 million tons. In 2020, poultry meat represented almost 40 percent of global meat production, Poultry provide humans with companionship, food and fiber in the form of eggs, meat and feathers (Hermans, 2012). There is a large commercial chicken industry that provides us with eggs and meat (Sullivan, 2012). The commercial egg laying industry is comprised of over 273 million laying hens, of which about 237 million produce table eggs (the eggs you buy at the supermarket) and the rest were for fertile hatching eggs as replacement for the laying flocks, With 48 billion pounds of meat produced, the poultry industry is the top agricultural industry in the U.S, The poultry industry is currently worth $310 billion, on the other hand, there's a huge issue which related to operators' clothes durability as after short time this fabric will be damaged because of its low mechanical properties. There's a huge obstacle at poultry industry that related to mechanical properties which operators at farms wear them as these kind fabrics damage and their durability so low (Hermans, 2012)

(1-1) Fibers:

- Bamboo fiber is a cellulosic fiber that is regenerated from bamboo plant (Meng, 2020). It is a great prospective green fiber with outstanding biodegradable textile material, having strength comparable to conventional glass fibers. Bamboo fiber has various micro-gaps, which make it softer than cotton and increase its moisture absorption (Remayanti, 2017). They are elastic, environment-friendly, and biodegradable (Zhou, 2019). The fiber is bacteriostatic, antifungal, antibacterial, hypoallergenic, hydroscopic, natural deodorizer, and resistant against ultraviolet light (Minami, 2012). Furthermore, it is highly durable, eco-friendly, stable and tough and has substantial tensile strength (Remayanti, 2017). Due to its versatile properties, bamboo fibers

are used mainly in textile industry for making attires, towels, and bathrobes (Zhou, 2019).
The drawbacks of bamboo fabric are minor compared to its many advantages. This natural material is sustainable and environmentally friendly because it requires reduced farming inputs like fertilizer, pesticides, and water in comparison with other types of fabrics which also require heavy harvesting machinery (Minami, 2012).

- Cotton is the world's favorite natural fiber. Its beauty, comfort, durability and versatility make it the perfect choice for clothing, bedding, textiles and many other products. As an industry, cotton supports the livelihoods of millions of people – both directly and indirectly – around the world.
  Cotton has been cultivated for at least 7000 years, making it one of the world's oldest known fibers. Despite this, its use did not become widespread until the invention of the cotton gin, which mechanized production (Soares, 2008). Cotton remains the most widely used natural fiber in the world and continues to be ever popular with consumers, the main features and benefits of cotton are comfortable, naturally sustainable supports farmers and communities, hypoallergenic, high mechanical properties (Saurabh, 2020).

- It's durable. Polyester fibers are incredibly strong, meaning they don't tear, stretch, or pill easily like cotton and other natural fibers (Demiryürek, 2016). This strength means polyester clothing can easily handle abrasion from machine-washing and doesn't require special care (Belsley, 2006). The durability of polyester fabric has made it especially popular for outdoor clothing (Gupta, 2008).

(1-2) Research Objectives:

The goal of this paper is to:

(1-3) The main purpose of this research is to study the differences in mechanical properties of various materials and different weave structures.

(1-4) Significance of research:

At poultry farms today, there are some issues, such as the clothing worn by the operators who work at poultry farms as it is not durable after a short period of use, it has been damaged due to the intensive usage of it (Hermans, 2012), So that we are aiming to produce durable fabrics that are suitable for this type of hard work and clothes must have a high mechanical property value.

- Producing various samples using different materials and weave structures.
- Finding the best fabric structure that can be utilized on poultry farms.
- By making fabric more durable, poultry farms can reduce their cost.

(1-5) Research Field:

Fabric industry, poultry farms, Fabric mechanical proberties, poultry farms needs, image recognition, and Fabric test.

(1-6) Research Methodology:

The study adopts an exploratory research design to investigate the effectiveness of the durable fabric on the poultry farms.

Furthermore, a descriptive research design with a survey technique was undertaken. As we made nine different sample to check the proberties and get the best sample which gives to us the highest mechanical proberties.

(1-7) Previous studies:

(2) Poultry production contributes to improving the economy of developing countries. Egg and meat are produced due to their high nutritional value. Therefore, chicken and poultry feathers are used in many industries. The livestock sector works to provide the right conditions needed by poultry or birds, including the right place to sleep, the nutrition of poultry, the amount of food and the clean water

provided to poultry. Poultry production also contributes to improving the income of developing countries by producing large numbers of poultry and thus improving the income of individuals and citizens. In addition, it reduces unemployment and provides jobs. Egypt's Dohan industry is an important and influential industry, employing approximately 5.2 million workers. This indicates that the number of people living on this industry is about 10 million citizens. Its investment is about 65 billion pounds and it produces nearly 1 billion 250 a day old chick, about 1 billion chickens and 8 billion table eggs annually.

The goal of poultry production: -
Poultry production by target is divided into two main sections:

1. Poultry production for meat production

Livestock production aims to produce poultry for the purpose of obtaining meat in order to provide sufficient meat commensurate with the needs of consumers and the volume of demand in the market. Poultry meat has a high level of food vim. Animal production in meat or poultry production follows appropriate diets such as poultry fattening system.

2. Poultry production for egg production

Obtaining eggs is one of the main objectives of livestock production from the poultry industry; Eggs provide many nutrients that are useful for the body, eggs contain iron and zinc and many vitamins such as vitamin D, Eggs are made up of two main parts. The first part is called whites. The second part is yolks. The yellow part is eggs. Notably, yolks contain high cholesterol, and eggs contain calcium that is important for the body and human health (Hermans, 2012).

Bamboo material:-

The bamboolant plant Bamboo, the so-called runway name for giant wooden plants, is the fastest growing wooden plant on the planet. It grows in tropical and semi-tropical areas and bambos fall under a family of Bambusoideae subfamily, with more than 1,500 different species. It's just a grass, but its height is different from most plants, where it's 30 centimetres in diameter.

Bamboo fibers consist of wide and narrow fiber layers arranged interchangeably as these layers contain fibers of cellulose and hemicellulose arranged in different directions and angles within its embryonic matrix along the longitudinal axis of bamboo fiber which increases the tensile strength of bamboo fibers so bamboo fibers are called natural fiberglass fibers, where they are.
Bamboo fibers can be yarn on their own or can also be mixed with other fibers such as cotton, Viscose, Modal, Polyester, and other fibers fiber used in textile industry is called Muso Bamboo Moso and bamboo fiber have a lot of applications in textile products such as underwear, Shirts, pants, medical gauze, medical masks, towels, bathrobes, family fabrics and other applications (Meng, 2020).
Bambo Fiber Features: -
Bamboo fibers have distinctive characteristics that make them outperform many and many traditional fibers including: -
1- Smoothness and brightness with low shrinkage and wrinkling rate, where the bambu has a soft texture that makes it closer to silk does not cause irritation or sensitivity to the skin adhesive to it
2. Breathability and cold sensation, reflected in the sense of comfort.
3. Low weight and high tensile strength due to the presence of cellulose fibers monolithic in parallel along the longitudinal axis of bamboo fibers,
4. Biodegradability.
5. Its ability to protect against ultraviolet radiation
6. Its natural resistance to bacteria and bad odors, is due to the presence of a substance called Kun Bamboo which is strongly associated with cellulose molecules in the fibre formation of bamboo fibres during the plant's natural growth process.
7. High absorption of dye. Textiles produced from bamboo fibers need less dye than cotton fibers need to reach the required color level
8. It has a high absorbability and moisture evaporation due to the bamboo fiber width containing many gaps and small holes which absorb and vaporize moisture giving a sense of comfort and ventilation where absorption is up to 13% (Remayanti, 2017).

Defects of bamboo fiber: -

Bamboo fabric also has negative properties along with its features including: -

Shrinkage: Bamboo fabric may contract after washing requiring special washing operations so that its normal size does not shrink.

Drying difficulty: Because of the nature of the fabric of the bamboo fabric that absorbs moisture as it takes a long time to dry and evaporate water from it, it may also weaken its structure when wet, and is similar to this characteristic natural cotton fabric.

High cost: In particular, raw natural bamboo fabric that is not added has any other fibres whether industrial or semi-industrial (Zhou, 2019).

Cotton Material:-

Cotton Production is one of the world's leading fields and is produced in huge and economical quantities. Cotton products are relatively inexpensive. Fiber can be manufactured in various forms of tissue ranging from lightweight laces to heavy sailing tissue and thick velvet. Cotton tissue is suitable for making a large variety of clothing, home furnishings and industrial uses and is useful in making disposable products; Such as towels, polishing fabrics, tea bags, tablecloths, bandages, costumes, disposable covers in hospitals and other medical uses (Saurabh, 2020).

Here are some of the most important qualities of cotton tissue: comfortable to wear it is a natural cellulose fiber, Its white color and whiteness index has a range of 90-100, high ability to absorb liquids, absorbs cotton fluids well and with great capacity, as the cotton cloth can absorb up to 27 times its weight in water, making cotton clothing comfortable because it absorbs sweat, which is why it uses cotton for towels and bath towels, It can be dyed in multiple colors, and cotton tissue is known for its high color retention ability. Shrink, cotton fabrics shrink when washed in water for the first time, some cotton clothes have become pre-shrunk (Kothari, 2009).

Various processing processes are developed to make cotton resistant to stains, water and mold, crease easily, but many cotton clothes are developed with a finish that helps the fabric to resist crease. The

fabric may weaken if cotton is exposed to sunlight for prolonged periods of time, resists static electricity, long staple cotton can be used in soft semi-silky fabrics, characterized by high flexibility ranging from 45% to 74%. Cotton fabric is characterized by its ability to withstand tensile strength. Long exposure to dry heat above 164 ° C will lead to gradual degradation, exposure to temperatures above 262 ° C cause rapid degradation and therefore its heat resistance is relatively high. Its resistance is good for alkalis, its exposure to hot diluted acids has been found to cause its disintegration, as well as for cold concentrated acids, its resistance to organic solvents is good, and it is also resistant to most common industrial and household solvents. Cotton textiles are highly durable and corrosion resistant (Soares, 2008).

Polyester Materials:-

Polyester fabric has become one of the most industrial fabrics used in various fields especially in clothing, coverings and other textile industries since the 1930s and 1940s, Polyester tissue is made by mixing coal, water, air and petroleum derived compounds with some acids in a high heat environment This tissue differs in flexibility, durability and ability to maintain its shape according to other chemical compounds that are added to polyester fiber, making it a fabric that can be used in different fields (Demiryürek, 2016).

Polyester is characterized by many things that make it suitable for many uses, the following are mentioned for these qualities: -

Polyester is a texture capable of probability of light base and acid materials, but it causes its erosion whenever it is in greater concentration and in a higher heat environment, Polyester fibers can tolerate most of the detergent without being adversely affected, but some detergents may cause erosion, such as detergents containing sterile phenol and cloform. High temperature probability, thanks to the high temperature melting polyester which reaches 250-300 ° C, Polyester is characterized by its potential for sunlight and non-corrosive because of it (Gupta, 2008), Polyester greatly absorbs oils, and it is difficult to get rid of oil spots if absorbed, The ease of changing the qualities of polyester and increasing its flexibility and

probability of different conditions, according to the method of manufacture, medium to Lightweight making it comfortable to wear for long periods, the durability of polyester fibers; They are better able to resist rupture, amalgamation and spray compared to natural fiber, making them desirable fabrics in the outdoor garment industry, easy to get rid of polyester garment curls, unlike nature fiber as linen and cotton that needs ironing, polyester fiber is water resistant; That is, they do not absorb and do not enter between them, making them stain resistant too, so they are suitable in making rain resistant tents and clothes, but they trap moisture underneath so it is recommended to avoid wearing them during hot seasons, The way polystyrene fiber fabric is made affects its texture, some have a coarse texture, some are soft and resemble the smoothness of natural silk, It is difficult to decompose in nature compared to natural fibers, making it contaminated with them (Belsley, 2006).

(2) Testing

Warp and Weft materials

Warp material for all of produced samples was 100% polyester with yarn count 150/1 Denir, on the other hand, 100% cotton yarn and 100% Bamboo yarn and blended yarn (50% Cotton, 50% Bamboo) were used for the weft with yarn count 60/2 NE for cotton and 30/1 NE for Bamboo, Bamboo yarn was supplied from CSA CO.

Specification of the machine used in producing fabric the samples under study.

The research samples were manufactured at faculty of applied arts Helwan University at junary 2023, using jacquard machine with the specifications shown in the table (1).

Table (1) Specification of the loom used in producing research samples

No.	Property	Specification
1	Weft insertion device	Rapier
2	Name of Loom	smit
3	Speed of machine	300 picks/min
4	Shedding device	jacquard
5	Name of jacquard	Staubli
6	Width of warp without selvedge	142
7	Reed count (Ends/cm)	9
8	Denting	8

Specification of produced fabrics.

To investigate the effect of bamboo fiber ratio on the produced fabric properties, nine samples were produced by using three different weft arrangement, material and three different weave structures (plain & twill & satin) as shown on table 5

Table (2) the operational specifications of produced samples

Sample NO.	Weft Arrangement	Weft ratio Variable parameter	Fabric Composition	Weave	Ends /cm	picks/ cm
1	COTTON	100%COTTON	70%PES, 30%CO.	PLAIN	72	30
2				TWILL		
3				SATIN		
4	BAMBOO	100%BAMBOO	70%PES, 30%BAMBOO	PLAIN		
5				TWILL		
6				SATIN		
7	1 COTTON: 1 BAMBOO	50%COTTON, 50%BAMBOO	70%PES, 15%COTTON, 15%BAMBOO	PLAIN		
8				TWILL		
9				SATIN		

Tensile Strength of the fabric

- Lotustex textile company laboratory
- Standard test method ASTM D5034

Tearing Strength of Fabric

- Lotustex textile company laboratory
- Standard test method ASTM D1424

Fabric Shrinkage

- Lotustex textile company laboratory
- Standard test method ISO 6330

Fabric Weight

- Lotustex textile company laboratory
- Standard test method LS&CO. 21

Results and Discussion

Tables: -

Table (3) Tear strength test of weft and warp yarn.

WARP	WEFT	Weaves	Sample NO.	TEAR STRENGTH - GRF	
				WARP	WEFT
100% Polyester	100%COTTON	PLAIN	1	8274 ± 0.73 A	8274 ± 0.73 A
		TWILL	2	4677 ± 0.55 A	4631 ± 26.5 A
		SATIN	3	4403 ± 0.76 A	4403 ± 0.76 A
	100%BAMBOO	PLAIN	4	3418 ± 0.73 C	3418 ± 0.73 C
		TWILL	5	1989 ± 0.55 C	1989 ± 26.5 C
		SATIN	6	1847 ± 0.76 C	1847 ± 0.76 C
	50%COTTON, 50%BAMBOO	PLAIN	7	4282 ± 0.73 B	4282 ± 0.73 B
		TWILL	8	4122 ± 0.55 B	4122 ± 26.5 B
		SATIN	9	4067 ± 0.76 B	4067 ± 0.76 B

*Note: Tear strength test was carried out according to test method ASTM D1424 – Device – Elmatear

Table (4) Tensile strength test of weft and warp yarn.

WARP	WEFT	Weave structure	Sample NO.	TENSILE STRENGTH - KGF	
				WARP	WEFT
100%POLYESTER	100%COTTON	PLAIN	1	182 ± 0.91 A	37 ± 0.85 A
		TWILL	2	193 ± 0.80 A	45 ± 0.77 A
		SATIN	3	178 ± 1.021 A	42 ± 0.97 A
	100%BAMBOO	PLAIN	4	165 ± 0.91 B	23 ± 0.85 B
		TWILL	5	166 ± 0.80 B	29 ± 0.77 B
		SATIN	6	155 ± 1.021 B	25 ± 0.97 B
	50%COTTON, 50%BAMBOO	PLAIN	7	110 ± 0.91 C	23 ± 0.85 B
		TWILL	8	126 ± 0.80 C	29 ± 0.77 B
		SATIN	9	116 ± 1.021 C	26 ± 0.97 B

*Note: Tear strength test was carried out according to test method ASTM D5034– Device – Titan 5 model 1710/05

Table (5) Shrinkage test of weft and warp yarn.

WARP	WEFT	Weave structure	Sample NO.	SHRINKAGE - (%)	
				WARP	WEFT
100%POLYESTER	100%COTTON	PLAIN	1	4 ± 0.08 A	.8 ± 0.046 A
		TWILL	2	-3.03 ± .053 B	.8 ± 0.029 A
		SATIN	3	-2.78 ± 0.083 B	-0.5 ± 0.038 A
	100%BAMBOO	PLAIN	4	-4.8 ± 0.08 C	-5.06 ± 0.046 C
		TWILL	5	-3.5 ± .053 C	-.5 ± 0.029 B
		SATIN	6	-2.7 ± 0.083 B	-2.8 ± 0.038 C
	50%COTTON, 50%BAMBOO	PLAIN	7	2.3 ± 0.089 B	-0.3 ± 0.046 B
		TWILL	8	-3 ± .053 A	-.5 ± 0.029 B
		SATIN	9	-1.8 ± 0.083 A	-1.5 ± 0.038 B

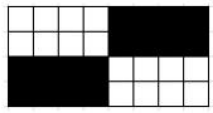
*Note: Shrinkage test was carried out according test method ISO 6330

Table (6) Fabric weight test of before and after washing.

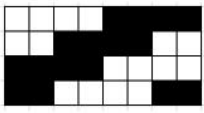
WARP	WEFT	Weave structure	Sample NO.	WEIGHT - GR/M²	
				BEFORE	AFTER
100%POLYESTER	100%COTTON	PLAIN	1	227 ± 0.85 A	216 ± 0.85 B
		TWILL	2	217 ± 0.76 B	222 ± 0.77 A
		SATIN	3	211 ± 0.86 B	218 ± 0.85 B
	100%BAMBOO	PLAIN	4	222 ± 0.85 B	244 ± 0.85 A
		TWILL	5	213 ± 0.76 C	222 ± 0.77 A
		SATIN	6	218 ± 0.86 A	230 ± 0.85 A
	50%COTTON, 50%BAMBOO	PLAIN	7	222 ± 0.85 B	218 ± 0.85 B
		TWILL	8	221 ± 0.76 A	218 ± 0.77 B
		SATIN	9	220 ± 0.86 A	227 ± 0.85 A

*Note: Fabric weight test was carried out according test method LS&CO. 21

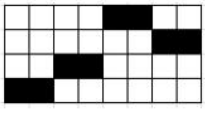
Illustrations and figures: -



"Fig. 1"
Plain weave structure Figure

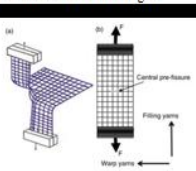


"Fig. 2"
Twill weave structure Figure



"Fig. 3"
Satin 4 figure

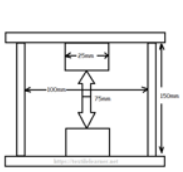
"Fig. 4"
Schematic representation of the tongue tear sample.



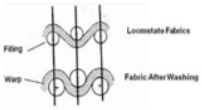
"Fig. 5"
Tongue tear sample configuration

"Fig. 6"
Tear Strength device

"Fig. 7"
Tensile strength device



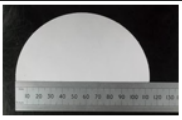
"Fig. 8"
Diagram of grab Tensile Strength test



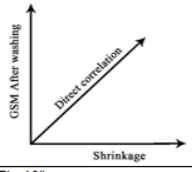
"Fig. 9"
Effect of warp shrinkage on yarn

"Fig. 10"
Fabric shrinkage ruler

"Fig. 11"
Cutter for fabric



"Fig. 12"
Sample cutting checker



"Fig. 13"
Correlation between weight and fabric shrinkage

(3) Conclusion:

Poultry farming is an animal farming that is among the most efficient. The mechanical properties of fabrics often determine their advantages (Hermans, 2012). The most importantly strength parameters involve tear strength, tensile strength, Cotton's mechanical properties are higher than bamboo's, To enhance its mechanical properties, it is suggested to use cotton and bamboo, The 100% cotton material with a plain weave structure gave us the best results in terms of tear strength, The twill weave structure on a 100% cotton material resulted in a satisfactory tensile strength result for us (Sullivan, 2012).

(4) Results:

In this paper, the various recommendation systems we have discussed guide consumers to the best fabric construction can be utilized for poultry farms.

- The weave plain's highest tear strength is determined by the test results, as it provides the highest tear strength values for all materials used for both weft and warp directions.
- The Twill weave structure is the best way to obtain the highest tensile strength of the fabric due to its highest values for both the weft and warp directions.
- For the shrinkage, it's changeable from the material to material as well it's changeable from weave to the weave structure as we note that the shrinkage for the same weave structures can be changed from material to material
- Shrinkage is the method that is most effective in fabric weight. Some materials have no shrinkage but only stretching. and As a result of that, we will notice The fabric will be lighter after washing than it was before based on the results of this stretch

(5) Recommends

- To achieve the highest tear strength from fabric, it is suggested to use a plain weave structure.
- Using a Twill weave structure is recommended when aiming for the highest tensile strength from the fabric.
- If we are going to use thin weft it's better to use air jet or water jet if we will not use natural material as if we will use Rapier as a way for weft insertion device we will find some difficulties during the implementation as it's hard for Rapier to hold the thin weft and as a result off it we will find the machine stopping repeating a lot of time

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تصميم وإنتاج أقمشة تقنية للحد من انتشار العدوي البكتيرية في معامل التفريخ ومزارع الدواجن

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المستخلص:

تربية الدواجن هي واحدة من أهم الصناعات في مصر والتي تحتاج إلى عدد كبير من العمال. ويعمل نحو ثلاثة ملايين شخص في هذه الصناعة. يجب أن تكون خصائص المنسوجات المستخدمة في مزارع تربية الدواجن مناسبة لظروف العمل الصعبة. ويجب التركيز على الخواص الميكانيكية لهذه الملابس لتكون لها متانة عالية أثناء الاستخدام. لإنتاج منسوجات لها عمر افتراضي عالي يجيب أن تكون الخواص الميكانيكية لها عالية.

وفي هذه البحث، تم انتاج أنواعًا مختلفة من الأقمشة التي يمكن استخدامها كملابس لعمال مزارع الدواجن باستخدام ماكينة نسيج رابير، وتم استخدام ثلاث خامات مختلفة وأنواع مختلفة من التراكيب النسجية وأجريت اختبارات للعينات النسجية المنتجة من البوليتسر والقطن والبامبو.

تم اختبار الخصائص الميكانيكية للأقمشة، كمقاومة التمزق وقوة الشد لها وكان التركيب النسجي يلعب دوراً رئيسياً فى نتائج هذة الاختبارات. مما اتاح لنا الفرصة لمعرفة مدي تأثير كل تركيب نسجي مستخدم على الخواص الميكانيكية للعينات, وتم توضيح هذه النتائج في هذا البحث مع جداول ورسوم بيانية لقيمة النتائج..

الكلمات المفتاحية

صناعة الدواجن ؛ المنسوجات التقنية ؛ الياف البامبو ؛ خامة القطن ؛ المواد المستدامة.