Anti-microbial Clothes for Cancer Patients Using Silver Nanoparticles

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Research Summary

Nanotechnology and its applications have revolutionized several industrial fields, which attracted the attention of scholars in various research fields, because it is a promising technology that heralds a tremendous leap in all branches of science by arranging the particles of matter next to each other in an unimaginable way and at the lowest possible cost, especially in the field of textile industries with regard to manufacture or preparartion. The current research aims to investigate nanotechnology and to benefit from it in making antimicrobial clothing in the medical field for cancer patients as to enhance the efficiency of the cotton fabrics used (Tinsel , Bamboo, and Febran), and to identify the best type of raw material, the best weaving construction, as well as the best concentration of the treatment substance,that is silver nanoparticles, for cotton fabrics under study with the purpose of resisting microbs for cancer patients. The significance of this research lies in taking advantage of the technological development in the field of clothing and textiles, applying nanotechnology to cotton fabric to raise its efficiency and improve its properties (tensile strength, elongation, absorption time) with purpose of meeting the functional purpose of antimicrobial resistance, and to treat cotton fabrics (using silver nanoparticles) in order to improve the functional performance of antimicrobial resistance. The research sample included three raw materials of weft yarn (100% Tinsel, 100% Bamboo, 100% Febran) with weaving constructions (Reverse weave, Honeycomb weave, and Crepe, crawl, spin weaves, and wrap yarns fixed for all fabrics produced, which is 100% cotton and were divided into 27 samples (20 cm). Three concentrations of the treatment substance (silver nanoparticles)

were used, namely (250 m/L, 500 m/L, and 750 m/L). Tests were carried out at both the National Institute of Standards and the National Research Center. The present research adopted both the descriptive-analytical method and the experimental method. Results revealed that Febran with weaving construction of Crepe crawl and spin, treated with silver nanoparticles at a concentration of 750 m/L is the best in resisting microbes, and it achieved the highest quality factor of (90.1417%) for all the different tests.

Keywords: Silver nanoparticles, nanotechnology, cancer patients.

ملابس مقاومة للميكروبات لمرضى السرطان باستخدام جسيمات الفضة النانوية

ملخص البحث

أحدثت تقنية النانو وتطبيقاتها ثورة فى مجالات صناعية كثيرة مما أدى إلى جذب إنتباه العاملين فى مجالات البحوث المختلفة، لأنها تقنية واعدة تبشر بقفزة هائلة فى جميع فروع العلوم وذلك عن طريق ترتيب جزيئات المادة إلى جانب بعضها البعض بشكل لا نتخيله وبأقل تكلفة ممكنه، وخاصة فى مجال الصناعات النسجية أثناء التصنيع أو التجهيز، **ويهدف البحث إلى** دراسة تكنولوجيا النانو و الاستفادة منها فى عمل ملابس مقاومة للميكروبات فى المجال الطبى لمرضى السرطان، ورفع كفاءة وتحسين الأقمشة القطنية المستخدمة (تنسيل، بامبو، فبران)، والوصول إلى أفضل نوع خامة وأفضل تركيب نسجى وأفضل تركيز لمادة المعالجة (جسيمات الفضة النانوية) للأقمشة القطنية تحت الدراسة لمقاومة الميكروبات لمرضى السرطان، **وتكمن أهمية البحث فى** الإستفادة من التطور التكنولوجى فى مجال الملابس والنسيج، تطبيق تكنولوجيا النانو على الأقمشة القطنية لرفع الكفاءة وتحسين خواصها (قوة الشد، الإستطالة، زمن الإمتصاص) لتفى بالغرض الوظيفى لمقاومة الميكروبات، ومعالجة الأقمشة القطنية (بجسيمات الفضة النانوية) لتحسين الأداء الوظيفى لمقاومة الميكروبات، وتمثلت عينة البحث فى استخدام ثلاثة خامات لخيط اللحمة (تنسيل100%، بامبو100%، فبران 100%) بثلاث تراكيب نسجية هى(أنسجة معكوسة، أنسجة هنيكوم، أنسجة كريب زحف ودوران وخيوط السدا ثابتة لجميع الأقمشة المنتجة وهى100% قطن وتم تقسيمها إلى 27عينة بمساحة 20سم واستخدام ثلاث تركيزات من مادة المعالجة جسيمات الفضة النانوية هى (250 م/لتر، 500م/ لتر،750م /لتر) وتم إجراء الإختبارات بمعهد القياس والمعايرة بالهرم والمركز القومى للبحوث بالدقى، واتبع البحث المنهج التحليلى والمنهج التجريبى، وتوصلت النتائج إلى أن الفبران بالتركيب النسجى كريب زحف ودوران المعالج بجسيمات الفضة النانوية عند تركيز 750م/لتر هو الأفضل فى مقاومة الميكروبات وقد حقق أعلى معامل جودة 90.1417% وذلك لجميع الاختبارات المختلفة .

الكلمات المفتاحية : جسيمات الفضة النانوية – تكنولوجيا النانو–مرضى السرطان

Introduction:

Nanotechnology is considered one of the future sciences, which is in increasing demand in industry, medicine, and the transportation sector, in addition to its promising applications in the field of medicine and health. A wide range of products use nanotechnology in their manufacture, including cosmetics, skin protection products, stain-resistant clothing, sports equipment, and substances for eyeglasses. In addition, nanotechnology is used as a basis for designing and manufacturing new systems of weapons and modern military technologies **(safat Salama: 2009**).

Moreover, the ability to control the sizes and dimensions of matter at the nanoscale leads us today to new technologies and it is expected to affect all aspects of our daily and economic lives. Therefore, there are new possibilities to detect diseases in their early stages via nanotechnology, which helps to treat them successfully, in addition to the development in medical, diagnostic and therapeutic systems, and the use of sensors in a large number of medical applications (**Mohamed AL-Dossary: 2012**).

It is noticeable that the science of nanotechnology is witnessing a remarkable and significant acceleration in all fields so that we cannot keep track of the developments taking place, or follow up the successive innovations or ongoing research. Thus, the word "nano" became one of the common words in the media. Scientists consider nanotechnology as one of the most important and greatest scientific achievement made by man in the present era. Hopes are placed on it in the development of the different aspects of life and helping humanity to live better. **(Munir Salem: 2011).**

Discoveries and research have remarkably developed to benefit from nanotechnology by searching for the possibility of using silver foil in the manufacture of silver jackets, protective or insulating layers, such as glasses based on nanotechnology used in cancer treatment using a fungus of not more than 100 nanometers, areas that repel rain, sun insulators called blue orchid, various

internal and external computer equipment, modern kitchen utensils, and the addition of fine particles to resistant dyes for clothing. Nanotechnology is considered highly efficient in limiting microbial growth, in addition to preventing the formation of microbial strains and sudden mutations that are resistant to many of the materials used in resistance to microbes.(**Abed Elohab Rajab: 2010).**

There are a wide array of research that focuses on the use of nanotechnology in the preparation and treatment of fabrics to resist microbes, such as the study of (**DaliaFathy: 2017**) which aimed to treat underwear fabrics to resist bacteria and microbes which are microorganisms that sometimes cause serious skin diseases which are difficult to get rid of and treat. The study concluded that chemical treatment against bacteria and microbes can contribute to accelerating the healing process of skin diseases.

In her study,(**sa lly El-Ashmawy :2016**) aimed to take advantage of nanotechnology in improving the functional performance of athletes' underwear. Results revealed that the best construction that achieve the functional performance properties of athletes' underwear is Jersey treated with nanometric silver particles at a concentration of (30 g/ml), whereas Ripe treated with silver nanoparticles at a concentration of (30 g/ml) was found to be the least to achieve such properties.

In the same vein, (**Sabra Al-Fahd :2014**) investigated the use of zinc oxide particles in the form of a nanocomposite in the treatment of fabrics used in the medical field to resist bacteria, in order to provide safety and complete protection for their users by achieving pollution prevention. The treatment of these fabrics gives them the properties of resistance to bacteria. This study concluded that such treatment leads to an increase in the amount of resistance to water permeation, due to the impregnation of the treatment subbstance by the spaces between the bristles, and filling these voids with the treatment substance.

The study of **(Hebeish,et,al .: 2011**) was carried out with aim of treating cotton fabrics with a solution of silver nanoparticles (molecular size >100ppm) in order to produce antibacterial fabrics that can be used in many fields, such as the medical field. This study reached the formation of particles in the nano size, which gave a resistance rate exceeding 98.96% to the two types of bacteria, namely Gm+ve and Gm-ve.

Given that hospital patients, especially cancer patients, suffer from immunodeficiency, they are the individuals who can become infected the most through microbes spread in hospitals. That is why this research is interested in nanotechnology because of its capabilities that allow it to be used in the preparation of antimicrobial clothing for cancer patients, that is resistant to infectious diseases.

The problem of the present research lies in the scarcity of clothes that help protect patients from diseases transmitted by bacteria and viruses, and which must suit their needs and be easey of use, whether for patients or escorts or the nursing staff and doctors. It also lies in the scarcity of research that is concerned with preparing antimicrobial medical clothes which cancer patients may be in dire need for due to conditions of weak immunity, which affects them negatively and leads to complications and infection with diseases. This was an impetus to keep pace with technological development, and to apply nanotechnology to make 100% cotton clothes that are resistant to microbes which cancer patients are exposed to while they are in the hospital for treatment or even outside the hospital to help them resist diseases that result from weak immunity.

The research problem is summarized in the following questions:

1-What is the possibility of benefiting from nanotechnology in preparing anti-microbial clothing for cancer patients?

2-What is the effect of the different concentrations of the treatment substance for silver nanoparticles on the cotton fabrics' resistance to microbs?

3-What is the best type of material (100% Tinsel weft thread, 100% Bamboo weft thread, 100% Febran weft thread), the best weaving construction (Reverse, Honeycomb, Crepe, crawl and spin), and the best concentration of the treatment substance (silver nanoparticles) that can be used in cancer patients' clothes?

Research aims:

1- Studying nanotechnology and its applications, and benefiting from it in making anti-microbial clothing in the medical field for cancer patients.

2- Improving and raising the efficiency of the cotton fabrics (Tinsel, Bamboo, Febran) used to resist microbes for cancer patients' clothes.

3- Reaching the best concentration of the treatment substance (silver nanoparticles) for cotton fabrics (Tinsel, Bamboo, Febran), the best type of material and the best weaving construction (Reverse, Honeycomb, Crepe, crawl and spin) to resist microbes for cancer patients.

Research significance:

1-Benefiting from the technological development in the field of clothing and textiles.

2- Applying nanotechnology to cotton fabrics to raise their efficiency and improve their properties (Tensile strength, elongation, absorption time, ultraviolet resistance) to meet the functional purpose of antimicrobials.

3- Providing medical clothes treated with safe substances that have no side effects and that resist microbes at the lowest economic cost.

Research Methodology

1-The current research adopted the experimental method in conducting tests, experiments and treatments (UPF, Tensile

strength, elongation, weight per squared meter g/m^2, absorption time, fungus of microbe inhibition on cotton fabrics using (Silver nanoparticles) with different concentrations for antimicrobial treatment. It also adopted the analytical method for analyzing the obtained results using statistical results.

Research sample:

The samples of the fabrics under study are weft yarn (100% Tinsel , 100% Bamboo, 100% Febran) and 100% cotton fixed wrap yarn with the weaving constructions (Reverse, Honeycomb, and Crepe, crawl and spin).

Research delimitations

1-**Time limits** :The research is applied in the First Semester of the academic year 2021/ 2022.

2- Tests were carried out at the National Institute of Standards, the National Research Center, and the textile factory in Mahalla al-Kubra for the production of three raw materials (100% Tinsel weft thread, 100% Bamboo weft thread, 100% Febran weft thread) and 100% cotton wrap threads of different weaving constructions (Reverse, Honeycomb, and Crepe, crawl and spin).

Research instruments

1- Silver nanoparticles in different concentrations (250 mM/L, 500 mM/L, 750 mM/L).

2- Equipment for laboratory tests (sterilization oven, lab, treatment substance (silver nanoparticles), lemon salt, polyethylene glycol).

Research hypotheses:

- There are statistically significant differences between the raw materials "Tinsel , Bamboo, and Febran " in the treatment with silver nanoparticles for weaving constructions (Reverse, Honeycomb, and Crepe) on the tests of UPF, tensile strength, elongation, weight per squared meter g/m2, absorption time, microbe inhibition fungus (Gm-ve, Gm +ve).

Research terms

1- Silver nanoparticle:

- It is ionized silver that takes the form of tiny spheres, and which has the mobility and ability to infiltrate tissues and penetrate the walls of living cells. (**Asmaa Abdel-Aty: 2018).**

- It is a nanoparticle of silver that ranges in size between 1 nanometer to 100 nanometers, and some of nanoparticles consist of a large percentage of silver oxide because of the big surface ratio the have compared to bulk silver atoms **(Dalia Fathy: 2017).**

- Silver nanoparticles can be operationally defined as nanoparticles that penetrate the walls of living cells in tissues to obtain textil products that are characterized by their resistance to bacteria and further improving functional properties.

2- Nanotechnology:

- It means designing, characterizing, producing, and applying the structures, devices, and systems by controlling shape and size at the nanometer scale. (**P.G.cooken &x.wang:2005**).

- Japanese researcher Norio Taniguchi has coined the term nanotechnology for the first time to express the methods of manufacturing micro-mechanical and electrical elements with high accuracy (Noah Al-Habashi: 2003).

- Nanotechnology can be operationally defined as a technology in which a unit of measurement called nano is used, which is one billionth of a meter, and it is a micro-technology.

3- Cancer patients:

- They are individuals who have been diagnosed as cancer patients by an oncologist through clinical and laboratory tests. (**Asmaa Rabhy: 2011)**

- Cancer patients can be operationally defined as individuals who suffer from tumors as a result of the abnormal growth of some tissues in the body, which leads to a defect in these tissues and the proliferation of cells at the expense of healthy tissues.

Theoretical framework:

Nano-silver:

Nano Silver is a powerful and natural antimicrobial agent that has been proved to be highly effective in combating a full range of microbes. It is said to inactivate an enzyme that bacteria, viruses, and single-celled fungi need in order to take up oxygen, without causing similar damage to human enzymes or other parts of the human body's chemistry. The result is the destruction of pathogenic organisms without any harmful effects on the surrounding human tissue (A.I.wasif ands.k.laga: 2009).

Silver nanoparticles (AgNPS) are considered antimicrobial agents, potent inhibitor as well as antibacterial. Antimicrobial polymers which are based on nanosilver represent a challenge to all academic and industrial circles. Silver is considered an inorganic and non-toxic metal, capable of killing organisms that cause diseases in the body, and has a low toxicity towards mammalian cells **(**A. Hebeish, M.E. El−Naggar **: 2011**).

Advantages of silver nanoparticles as antimicrobial:

- Silver nanoparticles are characterized by having strong toxic effects on a wide range of microorganisms, therefor they can attack the bacterial surface by penetrating these organisms and leading to disruption of the vital functions of the organism due to a change in the fluidity of the membrane, and thus increasing the permeability of the cell. In addition, bacterial membrane proteins contain sulfur and phosphorous in their structure, and each of the nanoparticles, such as silver ion can interact with these proteins and prevent DNA functions by interacting with these chemicals. Silver nanoparticles can also attack the respiratory chain in the mitochondria bacteria and lead to cell death (**Benjamin Le Ouay: 2015).**

- Furthermore, silver nanoparticles differ from most anti-microbial substances, as they are constantly active and are not consumed during the eradication of microbes which goes through three different mechanisms: preventing the respiration of the microbial cell, preventing the proliferation of this cell, and preventing its renewal, thus continuing its work in the long term as a microbicide until the end of the consumption period. This extends the functional life of the surfaces of the internal environment and reduces the spread of diseases
- They are effective in exterminating microbes since they have a large surface area that increases the chances of microbes coming into contact with them.
- They prevent the proliferation and growth of infection-causing microbes, as well as the presence of unpleasant odor and surface discoloration.
- They operate automatically without any harmful effect on humans or the environment (**Doaa Attia: 2016**).

Silver Nanoparticles (AGNPS) in Garment Applications:

A - They are ideal for clothing made of cotton, wool, silk, composite materials and leather. They can be applied to the finest silk and cotton uniforms, costumes, advertisements, jackets, T-shirts, blouses, sports jackets, pants, jeans, raincoats, motorcycle clothing, snowboarding and even adventure clothing. The fabric used by Al-Ahram newspaper workers (the commercial printing press) has been coated with AGNPS silver nanoparticles to improve its functional properties in order to meet end-use requirements. (Eman Rafat & Nashwa Mostafa**: 2014**).

B- Silver nanoparticles were also used in the manufacture of tissues that do not get wet and do not fade, and also in the production of anti-fungal socks and gloves, sports clothing and swimwear in order to prevent any bacterial or fungal activity from forming (**A beer Muhammad: 2018**).

Research procedures:

1. Theoretical study of research that dealt with (nanotechnology, cancer patients, silver nanoparticles).
2. Studying cancer and the health problems resulting from the disease.
3. Studying nanotechnology and its various applications in the field of clothing.

Applied part of research:

Practical experiments:

Instruments used in laboratory experiments:

1- Fabrics: The samples under investigation were produced in the textile factory in Mahalla al-Kubra.

A- Three different types of cotton fabrics were used, as follows: (100% Tinsel weft thread, 100% Bamboo weft thread, 100% Febran weft thread) and 100% cotton wrap thread.

B- Three different weaving constructions were used for each type of fabric, which are as follows: (Reverse, Honeycomb, and Crepe, crawl, spin).

• Specifications of the fabrics produced are as follows: experimental samples were carried out on a Dobby Rapier, the loom width is 190 cm.

Table (1): Specifications of the fabrics produced in this study

Fabric produced	**Specifications**
Warp yarn number	1/40 carding cotton
Weft yarn number	1/30 tinsel, bamboo, febran
Picks per inch	60picks per inch
Linear meter weight	156 gm
Square meter weight	148 gm
Reed count	19,2 /cm
Denting Fabric With selvedge	3 yarns/ dent
Countof yarns FabricWith selvedge in reed	57.6//cm
Reed warp width	108.6 cm

Count of warp thread	6255
Count of heddle frame used	10FabricWith selvages +2 selvedges+ 2 interleacing
Drawing-in type	Straight -Drawing-in

2- The substances used:

A- Silver nanoparticles in three different concentrations: (250 mM/L, 500 mM/L, and 750 mM/L).

b-Polyethylene glycol.

C - Lemon salt (citric acid).

Variable factors:

1- Concentration of the treatment substance (silver nanoparticles) (250, 500, 750 ml/L).

2- Weft thread raw materials (100% Tinsel , 100% Bamboo, 100% Febran).

3- Weaving constructions (Reverse weave, Honeycomb weave, and Crepe, crawl, spin weaves).

Preparation of fabrics produced under study:

1. Twenty seven samples of cloth were prepared, each sample is 20x20cm.

2. Samples were weighed before processing. Twenty seven samples were prepared using silver nanoparticles, 9 samples for each concentration, and the treatments were carried out as follows:

Silver nanoparticle treatment:

Three different concentrations were used: 250 M, 500 M, 750 M, and 9 samples for each concentration. One gm of silver nanoparticles was dissolved in 100 mm ethylene glycol with the addition of 2 gm of lemon salt in a liter of water with well stirring. Then, an amount of 250 ml of this solution was added to 750 ml of water with stirring to obtain the appropriate consistency. After the samples were immersed for 5 minutes in the solution, they were dried at 80°C for 3-5 minutes and were roasted at 120°C for 2 minutes. After that, the second concentration (500m) of the solution was added to 500 m of water. The samples were immersed for 5 minutes and the previous steps of drying and

roasting were repeated, then the third concentration (750 m) of the solution was added to 250 m of water. After that come immersion, drying at 80°C and roasting at 120 °m. The following figure shows the method of silver nanoparticles treatment after preparing the solution and then immersing the samples.

Figure (1): The nano-silver treatment

Tests carried out on the fabrics Under Study:

The Tensile strength and elongation tests were carried out at the National Institute of Standards, while the tests for resistance to bacteria, ultraviolet rays, absorption speed and weight were carried out at the National Research Center.

1- Square meter weight (g/m2) test for the samples under study was conducted before and after treatment using a sensitive balance.

2- Absorption time test (s): This test was carried out in accordance with American Standard Specifications No. (0608) for the year 2002 AD using a stopwatch.

3- Fabric tensile strength (Newton): Tensile properties of fabrics ISO 13934: Determination of maximum force and elongation at maximum force using the strip method. It is done by cutting three parts of the sample, each part with a sample length of 20 cm and a width of 3 cm, after fraying half a cm from each side as follows:

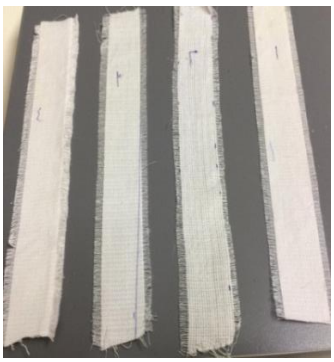

Figure (2): under study frayed samples of fabrics

- Elongation test (%): The elongation of the fabric samples is measured with the same tensile strength device, which is the amount of increase in the length of the bristles when exposed to the tensile force.

5- (UPF) test according to AS/NZS 4399-1999 standard specifications using UV-Shimadzu 3101-PC-Spectrophotometer

6- Bacterial growth resistance test (mm): This test was carried out according to the method of AATCC 100-Antimicrobial Fabric Test, and this test was conducted using an Agar plate to show the resistance of the samples under study to the activity of microbes. Four different types of microbes were selected as follows:

• Gram-positive bacteria: *Staphylococcus aureus*.
• Gram-negative bacteria*: Escherichia coli.*
• Fungus: *Candida albicans*.
• Fungus: *Aspergillus niger.*

Statistical method and treatment:

The following statistical methods were used

1- Analysis of variance (ANOVA) test to measure the significance of differences.

2- LSD multiple comparison test.

3-QualityAssessment.

Table (2): Test results for materials treated with silver nanoparticles

Sample No.	Treatment Sbstance	Material	Weaving Construction	Treatment Sbstance Concentration (gm)	UPF (0)	Tensile Strength (kgm)	Elongation (%)	Square Meter Weight (gm/m2)	Absorbtion Time (Sec.)	Microbe inhibition fungus			
										Gm ve+ *Staphylococcus aurous*	Gm Ve– *Escherichia coli*	*Candida albicans*	*Aspergillus niger*
–	Silver nanoparticles	Tinsel	Reverse	–									
1				250	27	470,2	6.440	6,31	2،7	12	13	12	13
2				500	33	661.5	6,515	6,53	2,5	14	14	13	14
3				750	39	672.86	6,589	6,30	2	15	16	16	14
–			Honeycomb	–	–	–	–	–	–	–	–	–	–
4				250	28	590.4	6.577	6,150	2	13	13	12	13
5				500	36	660,7	6.066	6,32	2,5	14	14	13	13
6				750	44	693.8	5.639	7,35	3	15	15	14	14
–			Crepe	–	–	–	–	–	–		–	–	–
7				250	31	543,5	7.703	6,90	1,7	12	13	13	14
8				500	41	550.7	7.788	6,63	1,5	15	14	14	16
9				750	46	570.5	8.210	7,15	1,3	15	15	16	16
–		Velvet		–	–	–	–	–	–	–	–	–	–

10				250	27	313,1	6,302	7,69	3،6	13	14	14	14
11				500	40	322,3	6,560	7,83	3	15	15	15	14
12				750	42	370.2	6.643	7,50	2,5	16	17	17	15
–			Honeycomb	–	–	–	–	–	–	–	–	–	–
13				250	29	658.5	5,443	7,45	2,6	14	15	14	14
14				500	37	663.0	5,478	7,83	8،2	15	17	14	15
15				750	45	680.5	6.761	8,25	3	16	18	16	17
–			Crepe	–	–	–	–	–	–	–	–	–	–
16				250	29	684،8	5.060	7,75	1,8	12	14	13	15
17				500	39	696.5	5.208	7,85	1،6	16	16	15	17
18				750	45	743.5	5,918	8,43	1,4	17	17	18	18
–		Febran	Reverse	–	–	–	–	–	–	–	–	–	–
19				250	30	570.3	5.730	6,51	2،7	14	14	16	15
20				500	41	640.5	6.029	6,70	2,5	16	17	16	15
21				750	45	662.5	10.158	7,7	2,2	17	17	18	17
–			Honeycomb	–	–	–	–	–	–	–	–	–	–
22				250	29	648,5	4.640	6,78	2	15	16	15	16
23				500	41	558,6	5,333	7,71	2,4	16	17	16	16

24				750	46	671.0	5,690	7,37	2،8	17	20	18	19
–			Crepe	–	–	–	–	–	–	–	–	–	–
25				250	31	694.8	5.038	6,85	2,8	13	15	15	17
26				500	41	713.5	5.303	7,12	2،4	17	18	16	19
27				750	47	729.1	5.343	7,70	2	19	20	21	20

Table (3): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the (UPF) test

UPF	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	146.327	18.291	8	41.154	0.01 Sig.
Within Groups	8.000	0.444	18		
Total	154.327		26		

It is clear from table (3) that the value of (F) is (41.154), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials "Tinsel , Bamboo, Febran " in the treatment with silver nanoparticles for weaving constructions (Reverse weave, Honeycomb weave, and Crepe, crawl, spin weaves) on the UPF test. To find out the direction of the significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (4): LSD Multiple Comparison Test

UPF		Tinsel			Bamboo			Febran		
		Reverse M=39.0	Honey-comb M=44.0	Crepe M=46.0	Reverse M=42.0	Honey-comb M=45.0	Crepe M=45.1	Reverse M=45.2	Honey-comb M=46.1	Crepe M= 47.0
Tinsel	Reverse	-								
	Honey-comb	**5	-							
	Crepe	**7	**2	-						
Bamboo	Reverse	**3	**2	**4	-					
	Honey-comb	**6	**1	**1	**3	-				
	Crepe	**6.1	**1.1	*0.9	**3.1	0.1	-			
Febran	Reverse	**6.2	**1.2	*0.8	**3.2	0.2	0.1	-		
	Honey-comb	**7.1	**2.1	0.1	**4.1	**1.1	**1	*0.9	-	
	Crepe	**8	**3	**1	**5	**2	**1.9	**1.8	*0.9	-

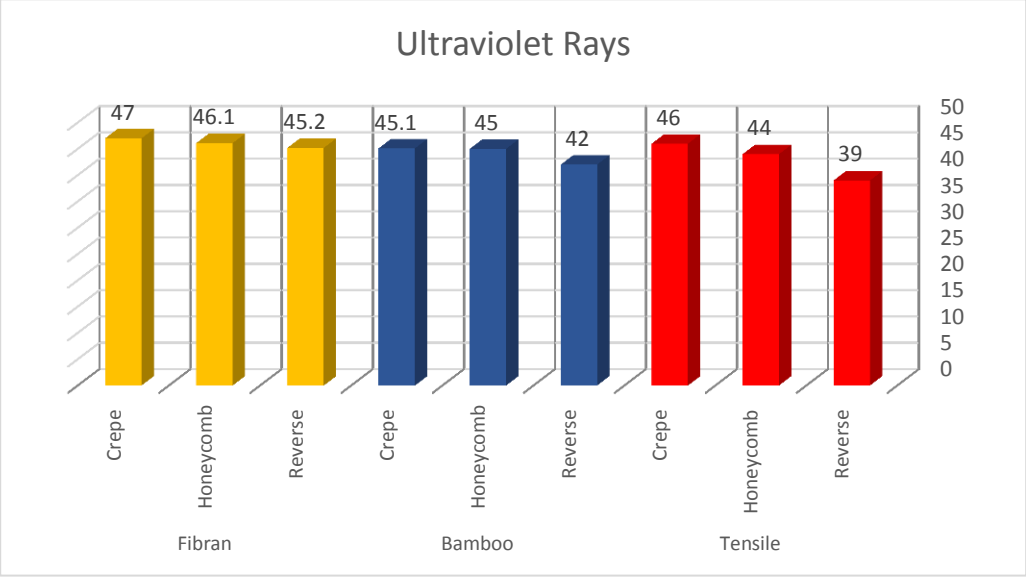

Figure (1): Averages of the raw materials treated with silver nanoparticles for the weaving constructions in the (UPF) test.

Table (4) and figure (1) show the following:

1- There are statistically significant differences at the level of (0.01) between the raw materials “Tinsel , Bamboo, Febran” on the treatment with silver nanoparticles for the weaving constructions “Reverse, Honeycomb, Crepe” in the UPF test. Febran Crepe comes in the first place, followed by the Febran Honeycomb, Tinsel Crepe, Reverse Febran, Bamboo Crepe, Bamboo Honeycomb, Tinsel Honeycomb, Reverse Bamboo, and Reverse Tinsel, respectively.

2- There are also differences at the significance level of (0.05) between Tinsel Crepe and Bamboo Crepe in favor of Tinsel Crepe, and there are statistically significant differences at the level of (0.05) between Tinsel Crepe and Reverse Febran in favor of Tinsel Crepe. In addition, there are statistically significant differences at the level of (0.05) between Reverse Febran and Febran Honeycomb in favorof Febran Honeycomb. There are also differences at the significance level of (0.05) between Febran Honeycomb and Febran Crepe in favor of Febran Crepe.

3- There are no differences between Tinsel Crepe and Febran Honeycomb, Bamboo Honeycomb and Bamboo Crepe, Bamboo Honeycomb and Reverse Febran, and Bamboo Crepe and Reverse Febran .

We conclude from table (3,4) and figure (1) that Febran Crepe ranks first for resistance to ultraviolet rays with a value of (47), followed by Febran Honeycomb with a value of (46), while Reverse Tinsel comes the last with the lowest value of (39). The higher the concentration of nano-silver is, the higher the resistance to ultraviolet rays is.

Table (5): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the tensile strength test (newtons).

Tensile strength	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	308016.491	38502.061	8	39.820	0.01 Sig.
Within Groups	17404.323	966.907	18		
Total	325420.814		26		

It is clear from table (5) showed that the value of (F) is (39.820), which is a statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials "Tinsel,Bamboo, Febran"in the treatment with silver nanoparticles for weaving constructions "Reverse, Honeycomb, Crepe" on the tensile strength test. To find out the direction of significance, the LSD test for multiple comparisons was applied, see table (6):

Table (6): LSD Multiple Comparison Test

Tensile strength		Tinsel			Bamboo			Febran		
		Reverse M=672.86	Honey-comb M=693.80	Crepe M=570.50	Reverse M=370.20	Honey-comb M=680.50	Crepe M=743.50	Reverse M= 662.50	Honey-comb M=671.00	Crepe M= 729.1
Tinsel	Reverse	-								
	Honey-comb	*20.940*	-							
	Crepe	*102.360*	*123.300*	-						
Bamboo	Reverse	*302.660*	*323.600*	*200.300*	-					
	Honey-comb	*7.640*	*13.300*	*110.000*	*310.300*	-				
	Crepe	*70.640*	*49.700*	*173.000*	*373.300*	*63.000*	-			
Febran	Reverse	*10.360*	*31.300*	*92.000*	*292.300*	*18.000*	*81.000*	-		
	Honey-comb	1.860	*22.800*	*100.500*	*300.800*	*9.500*	*72.500*	*8.500*	-	
	Crepe	*56.240*	*35.300*	*158.600*	*358.900*	*48.600*	*14.400*	*66.600*	*58.100*	-

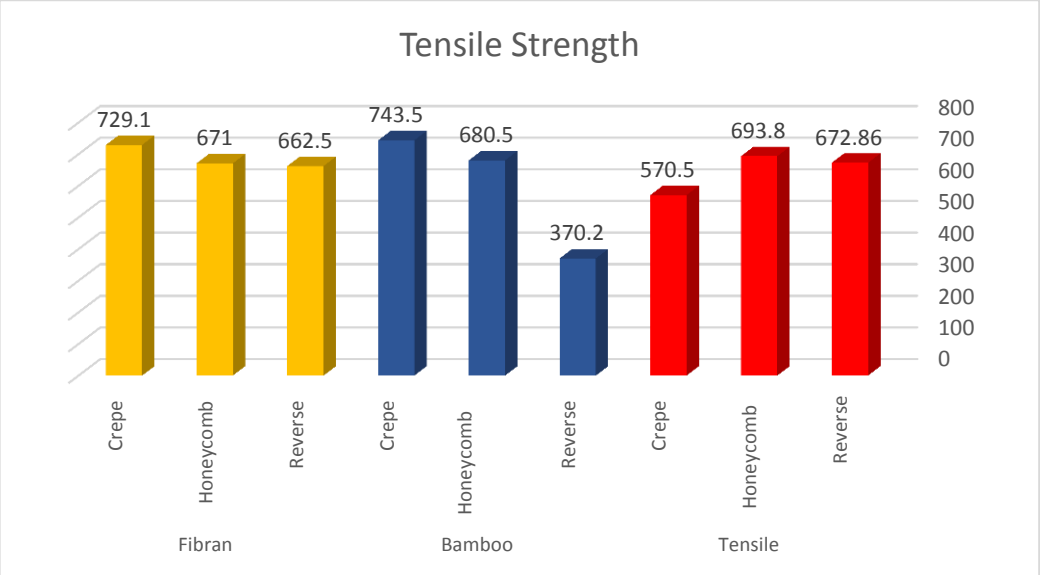

Figure (2): Averages of the raw materials treated with silver nanoparticles for the weaving constructions in the tensile strength test (Newton).

It is clear from table (6) and figure (2) showed that:

1. there are statistically significant differences at the level of (0.01) between mean scores of the raw materials "Tinsel, Bamboo, Febran" in the treatment with silver nanoparticles for weaving constructions “Reverse, Honeycomb, Crepe" on the tensile strength test. Bamboo Crepe comes in the first place, followed by Febran Cepe, Tinsel Honeycomb, Bamboo Honeycomb, Reverse Tinsel , Febran Honeycomb, Tencel Crepe, and Reverse Bamboo, respectively.
2. there are no differences between Reverse Tinsel and Febran Honeycomb.

It can be concluded from table (5,6) and figure (2) showed that Bamboo Crepe comes in the first place with a tensile strength value of (743.5) due to the low intersections and high coefficient of twisting of the threads, followed by Febran Crepe with a tinsel strength of (729.1), and then comes Reverse Bamboo with a tensile strength of (370,2). The presence of interconnections is Mor in weaving construction (Reverse)

Table (7): Analysis of variance of the mean scores of raw materials in treatment with silver nanoparticles for weaving construction on the elongation test (%)

Elongation %	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	57.525	7.191	8	27.833	0.01 Sig.
Within Groups	4.650	0.258	18		
Total	62.175		26		

It is clear from table (7) showed that the value of (F) is (27.833), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel, Bamboo, Febran” in the treatment with silver nanoparticles for weaving constructions “Reverse, Honeycomb, Crepe" on the tensile strength test. To find out the direction of significance, the LSD test for multiple comparisons was applied, see table (8):

Table (8): LSD Multiple Comparison Test

Elo ngation %		Tinsel			Bamboo			Febran		
		Reverse 672.86M=	Honey-comb M= 693.80	Crepe M= 570.50	Reverse 672.86M=	Honey-comb 693.80M=	Crepe 570.50M=	Reverse M= 672.86	Honey-comb M= 693.80	Crepe M 570.50=
Tinsel	Reverse	–								
	Honey-comb	**0.950	–							
	Crepe	**1.621	**2.571	–						
Bamboo	Reverse	0.054	**1.004	**1.567	–					
	Honey-comb	*0.172	**1.122	**1.449	*0.118	–				
	Crepe	**0.671	**0.279	**2.292	**0.725	**0.843	–			
Febran	Reverse	**3.569	**4.519	**1.948	**3.515	**3.397	**4.240	–		
	Honey-comb	**0.899	0.051	**2.520	**0.953	**1.071	**0.228	**4.468	–	
	Crepe	**1.246	**0.296	**2.867	**1.300	**1.418	**0.575	**4.815	**0.347	–

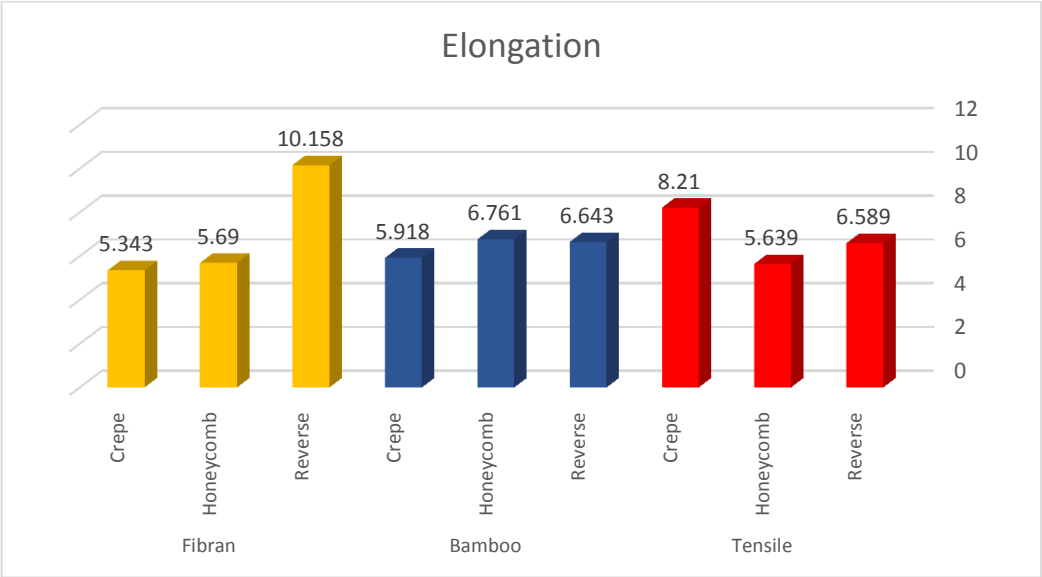

Figure (3): Averages of the raw materials treated with silver nanoparticles for the weaving construction in the elongation test (%).

Table (8) and figure (3) reveal the following:

1- there are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran " in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the elongation test, in which Reverse Febran comes in the first place, followed by Tinsel Crepe, Bamboo Honeycomb, Reverse Bamboo, Reverse Tinsel , Bamboo Crepe, Febran Honeycomb, Tinsel Honeycomb, and Febran Crepe, respectively.

2- There are also differences at the significance level of (0.05) between Reverse Tinsel and Bamboo Honeycomb in favor of Bamboo Honeycomb. In addition, differences at the level of significance of 0.05 were found between Reverse Bamboo and Bamboo Honeycomb in favor of Bamboo Honeycomb.

3- there are no differences between Reverse Tinsel and Reverse Bamboo, while there are no differences between Honeycomb Tinsel and Febran Honeycomb.

We conclude from tables (7 & 8) and figure (3) showed that Reverse Febran comes in the first place in the elongation rate with

a value of (10.158%) and the elongation increases with the increase in the concentration of nano-silver, and this is explained by the fact that there is a slip in the Febran fibers. Then comes Tinsel Crepe with a value of (8,210%) and Crepe Febran with a value of (7,70%), respectively.

Table (9): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the weight test (g/m2)

Square meter Weight (g/m2)	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	153.863	19.233	8	11.920	0.01 Sig.
Within Groups	29.044	1.614	18		
Total	182.907		26		

Table (9) shows that the value of (F) is (11.920), which is a statistically significant at the level of (0.01), and this indicates that there are differences between the mean scores of raw materials “Tinsel , Bamboo, Febran” in the treatment with silver nanoparticles for weaving constructions "Renverse, Honeycomb, Crepe" on the square meter weight test. To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (10): LSD Multiple Comparison Test

Weight (g/m2)		Tinsel			Bamboo			Febran		
		Reverse M=6.30	Honey-comb M=7.35	Crepe M=7.15	Reverse M=7.50	Honey-comb M=8.25	Crepe M=8.43	Reverse M=7.70	Honey-comb M= 7.37	Crepe M=7.71
tinsel	Reverse	–								
	Honey-comb	*1.050*	–							
	Crepe	*0.850*	*0.200*	–						
Bamboo	Reverse	*1.200*	*0.150	*0.350*	–					
	Honey-comb	*1.950*	*0.900*	*1.100*	*0.750*	–				
	Crepe	*2.130*	*1.080*	*1.280*	*0.930*	*0.180	–			
Febran	Reverse	*1.400*	*0.350*	*0.550*	*0.200*	*0.550*	*0.730*	–		
	Honey-comb	*1.070*	0.020	*0.220*	*0.130	*0.880*	*1.06*	*0.330 *	–	
	Crepe	*1.410*	*0.360*	*0.560*	*0.210*	*0.540*	*0.720*	0.010	*0.340 *	–

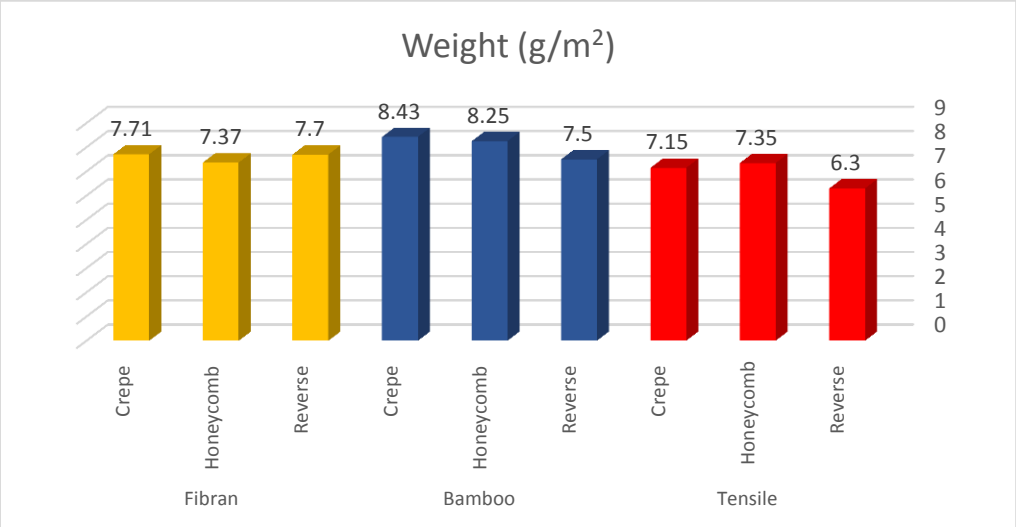

Figure (4): Averages of the raw materials treated with silver nanoparticles weaving constructions in the weight test (g/m2)

Table (10) and Figure (4) reveal) showed that:

1- there are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the weight test. Bamboo Crepe comes in the first place, followed by Bamboo Honeycomb, Bamboo Crepe, Febran Crepe, Reverse Febran, Reverse Bamboo, Febran Honeycomb, Tinsel Honeycomb, Tinsel Crepe, and Reverse Tinsel, respectively.

2- there are also differences at the significance level of (0.05) between Tinsel Honeycomb and Reverse Bamboo in favor of Reverse Bamboo. In addition, differences at the level of significance of (0.05) were found between Reverse Bamboo and Febran Honeycomb in favor of Reverse Bamboo. Besides, there are differences at the significance level of (0.05) between Bamboo Honeycomb and Bamboo Crepe in favor of Bamboo Crepe.

3- There are no differences between Tinsel Honeycomb and Febran Honeycomb, while there are no differences between Reverse Febran and Febran Crepe.

It can be concluded from tables (9 & 10) and figure (4) that Bamboo Crepe comes in the first place in the weight test with a value of (8.43 g/m2). This is due to the existence of irregular areas in the Bamboo fibers and the presence of spaces between the bristles compared to their counterparts in the Febran and Tinsel, and this also can be attributed to the nature of the weaving construction and the increase in the distances between the bristles.

Table (11): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving construction on the absorption time test (sec.)

Absorption Time Test (Sec.)	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	11.880	1.485	8	5.728	0.01 Sig.
Within Groups	4.667	0.259	18		
Total	16.547		26		

It is clear from table (11) showed that the value of (F) is (5.728), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel, Bamboo, Febran” in the treatment with silver nanoparticles for weaving constructions "Renverse, Honeycomb, Crepe" on the absorption time test. To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (12): LSD Multiple Comparison Test

Absorption Time Test (Sec.)		Tinsel			Bamboo			Febran		
		Reverse M=2.00	Honey-comb M=3.00	Crepe M=1.30	Reverse M=2.50	Honey-comb M=3.01	Crepe M=1.40	Reverse M=2.20	Honey-comb M=2.80	Crepe M= 2.01
Tinsel	Reverse	–								
	Honeycomb	*1*	–							
	Crepe	*0.7*	*1.7*	–						
Bamboo	Reverse	*0.5*	*0.5*	*1.2*	–					
	Honeycomb	*1.01*	0.01	*1.71*	*0.51*	–				
	Crepe	*0.6*	*1.6*	*0.1	*1.1*	*1.61*	–			
Febran	Reverse	*0.2*	*0.8*	*0.9*	*0.3*	*0.81*	*0.8*	–		
	Honeycomb	*0.8*	*0.2*	*1.5*	*0.3*	*0.21*	*1.4*	*0.6*	–	
	Crepe	0.01	*0.99*	*0.71*	*0.49*	*1*	*0.61*	*0.19	*0.79*	–

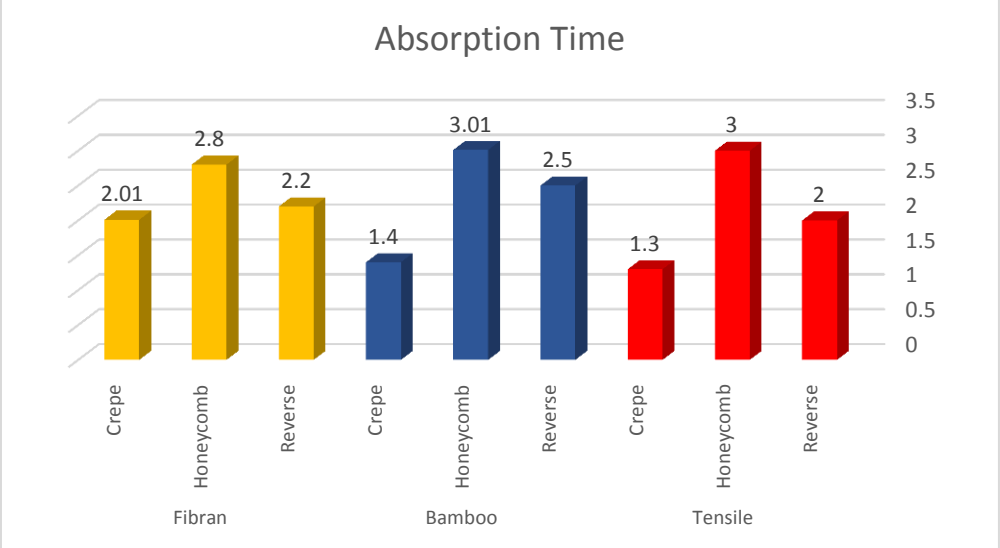

Figure (5): Averages of the raw materials treated with silver nanoparticles for the weaving construction in the absorption time test (Sec.)

It is clear from table (12) and figure (5) showed that:

1- There are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the absorption time test. Tinsel Crepe comes in the first place, followed by Bamboo Crepe, Reverse Tinsel, Febran Crepe, Reverse Febran, Reverse Bamboo, Febran Honeycomb, Tinsel Honeycomb, and Bamboo Honeycomb, respectively.

2- There are also differences at the significance level of (0.05) between Tinsel Crepe and Bamboo Crepe in favor of Tinsel Crepe. In addition, differences at the level of significance of (0.05) were found between Reverse Febran and Febran Crepe in favor of Febran Crepe.

3- There are no differences between Reverse Tinsel and Febran Crepe, while there are no differences between Tinsel Honeycomb and Bamboo Honeycomb.

It can be concluded from tables (11 & 12) and figure (5) showed that tinsel with the weaving construction "Crepe" comes is the best in the absorption time with a value of (1.3 Secs.), and the raw material of Bamboo Honeycomb takes longest absorption time and this is because the tissues of the Honeycomb are characterized

by the existence of voids that increase the density of the threads and that the absorption time increases with the increase in concentration. This is due to the decrease in the intersections in the Crepe and the short absorption time.

Table (13): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the test of microbe inhibition fungus (Gm+Ve).

Microbe Inhibition Fungus (Gm+Ve)	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	40.299	5.037	8	15.112	0.01 Sig.
Within Groups	6.000	0.333	18		
Total	46.299		26		

It can be noted from table (13) showed that the value of (F) is (15.112), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel, Bamboo, Febran” in the treatment with silver nanoparticles for weaving constructions "Renverse, Honeycomb, Crepe" on the test of microbe inhibition fungus (Gm+Ve). To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (14): LSD Multiple Comparison Test

Microbe I nhibition Fungus (Gm+Ve)		Tinsel			Bamboo			Febran		
		Reverse M=15.00	Honey-comb M= 15.10	Crepe M= 15.11	Reverse M= 16.00	Honey-comb M= 16.10	Crepe M= 17.00	Reverse M= 17.01	Honey-comb M= 17.02	Crepe M= 19.00
Tinsel	Reverse	–								
	Honey-comb	*0.1	–							
	Crepe	*0.11	0.01	–						
Bamboo	Reverse	*1*	*0.9*	*0.89*	–					
	Honey-comb	*1.1*	*1*	*0.99*	*0.1	–				
	Crepe	*2*	*1.9*	*1.89*	*1*	*0.9*	–			
Febran	Reverse	*2.01*	*1.91*	*1.9*	*1.01*	*0.91*	0.01	–		
	Honey-comb	*2.02*	*1.92*	*1.91*	*1.02*	*0.92*	0.02	0.01	–	
	Crepe	*4*	*3.9*	*3.89*	*3*	*2.90*	*2*	*1.99*	*1.98*	–

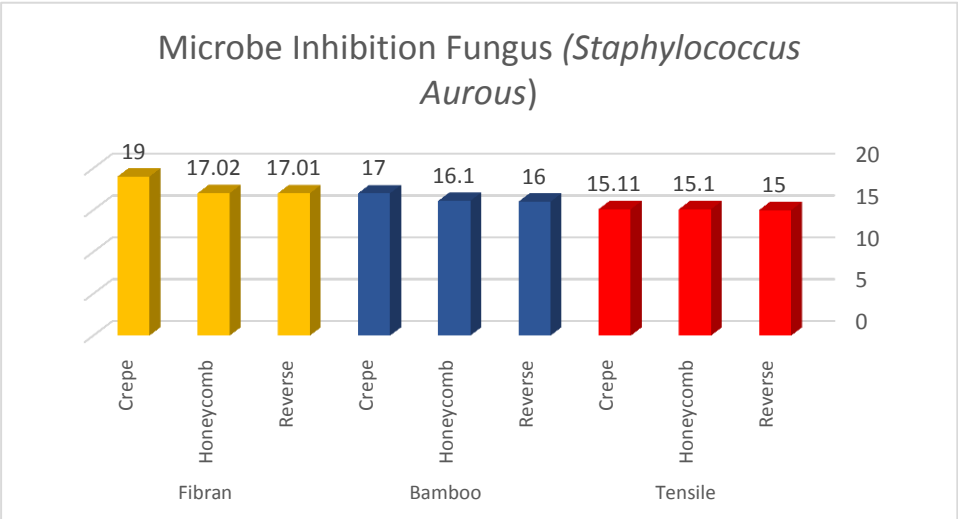

Figure (6): Averages of the raw materials treated with silver nanoparticles for the weaving constructions in the test of microbe inhibition fungus (*Staphylococcus Aurous*)

It is clear from the table (14) and figure (6) showed that:

1- There are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the microbe inhibition fungus test. Febran Crepe comes in the first place, followed by Febran Honeycomb, Reverse Febran, Bamboo Crepe, Bamboo Honeycomb, Reverse Bamboo, Tinsel Crepe, Tinsel Honeycomb, and Reverse Tinsel, respectively.

2- There are also differences at the significance level of (0.05) between Reverse Tinsel and Tinsel Honeycomb in favor of Tinsel Honeycomb. In addition, differences at the level of significance of (0.05) were found between Reverse Tinsel and Tinsel Crepe in favor of Tinsel Crepe. Besides, there are differences at the significance level of (0.05) between Reverse Bamboo and Bamboo Honeycomb in favor of Bamboo Honeycomb.

3- There are no differences between Tinsel Honeycomb and Tinsel Crepe, while there are no differences between Bamboo Crepe and Reverse Febran. Furthermore, there are no differences between Bamboo Crepe and Febran Honeycomb, and between Reverse Febran and Febran Honeycomb.

It can be concluded from tables (13 & 14) and figure (6) showed that weaving construction "Febran Crepe" has the highest value (19) for resistance to Gram-positive bacteria "*Staphylococcus Aureus* (Gm+Ve). This is explained by the few intersections in the weaving construction "Crepe", surface roughness and its resistance to bacteria.

Table (15): Analysis of variance for the mean scores of materials treated with silver nanoparticles for weaving construction on the test of microbe inhibition fungus (Gm-Ve) .

Microbe Inhibition Fungus (Gm-Ve)	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	84.062	10.508	8	23.642	0.01 Sig.
Within Groups	8.000	0.444	18		
Total	92.062		26		

It can be noted from table (15) showed that the value of (F) is (23.642), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel , Bamboo, Febran ” in the treatment with silver nanoparticles for weaving constructions "Renverse, Honeycomb, Crepe" on the test of microbe inhibition fungus (Gm-Ve). To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (16): LSD Multiple Comparison Test

Microbe Inhibition Fungus (Gm-Ve)		Tinsel			Bamboo			Febran		
		Reverse M= 16.00	Honey-comb M= 15.00	Crepe M= 15.01	Reverse M= 17.00	Honey-comb M= 18.00	Crepe M= 17.11	Reverse M= 17.03	Honey-comb M= 20.00	Crepe M= 20.10
Tinsel	Reverse	–								
	Honey-comb	***1***	–							
	Crepe	***0.99***	**0.01**	–						
Bamboo	Reverse	***1***	***2***	***1.99***	–					
	Honey-comb	***2***	***3***	***2.99***	***1***	–				

	Crepe	*1.11*	*2.11*	*2.1*	*0.11	*0.89*	–			
Febran	Reverse	*1.03*	*2.03*	*2.02*	0.03	*0.97*	0.08	–		
	Honey-comb	*4*	*5*	*4.99*	*3*	*2*	*2.89*	*2.97*	–	
	Crepe	*4.1*	*5.1*	*5.09*	*3.1*	*2.1*	*2.99*	*3.07*	*0.1	–

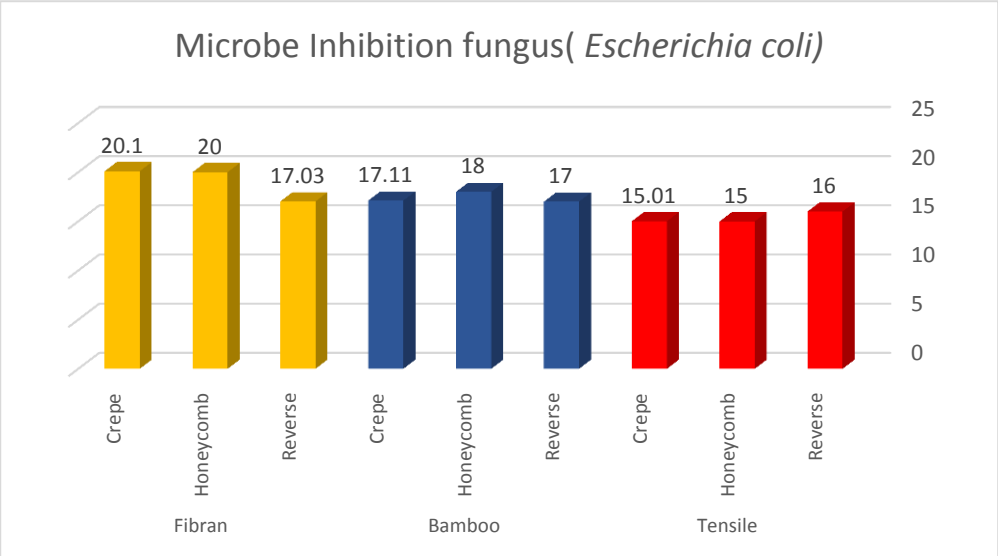

Figure (7): Averages of the raw materials treated with silver nanoparticles for the weaving constructions in the test of microbe inhibition fungus (*Escherichia coli*)

It can be noted from table (16) and figure (7) showed that:

1- There are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the microbe inhibition fungus test (Gm-Ve) *Escherichia coli*. Febran Crepe comes in the first place, followed by Febran Honeycomb, Bamboo Honeycomb, Bamboo Crepe, Bamboo Honeycomb, Reverse Bamboo, Reverse Tinsel, Tinsel Crepe, and Tinsel Honeycomb, respectively.

2- There are also differences at the significance level of (0.05) between Reverse Bamboo and bamboo Crepe in favor of bamboo Crepe. In addition, differences at the level of significance of (0.05) were found between Febran Honeycomb and Febran Crepe in favor of Febran Crepe.

3- There are no differences between Tinsel Honeycomb and Tinsel Crepe, while there are no differences between Reverse Bamboo and Reverse Febran. Furthermore, there are no differences between Bamboo Crepe and Reverse Febran.

It can be concluded from tables (15 & 16) and figure (7) showed that weaving constructions "Febran Crepe" and "Febran Honeycomb" have the highest value (20) at a concentration of (750 m) in *Escherichia coli* (Gm-Ve) resistance. This is due to the fact that the Febran fibers were modified and treated during manufacturing, in addition to the fact that the Crepe tissues are resistant to bacteria due to the few intersections in it, followed by Bamboo Honeycomb with a value of (18), and finally comes Tinsel Honeycomb.

Table (17): Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the test of microbe inhibition fungus *(Candida albicans*).

Microbe Inhibition Fungus (Candida albicans)	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	92.657	11.582	8	34.747	0.01 Sig.
Within Groups	6.000	0.333	18		
Total	98.657		26		

It can be noted from table (17) showed that the value of (F) is (34.747), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel, Bamboo, Febran” in the treatment with silver nanoparticles for weaving constructions "Renverse,

Honeycomb, Crepe" on the test of microbe inhibition fungus (Candida albicans). To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (18): LSD Multiple Comparison Test

mi robe Inhibition Fungus Candida albicans)		Tinsel			Bamboo			Febran		
		Reverse M= 16.00	Honey-comb M=15.00	Crepe M=15.01	Reverse M=16.00	Honey-comb M=15.00	Crepe M=15.01	Reverse M= 16.00	Honey-comb M= 15.00	Crepe M= 15.01
Tinsel	Reverse	–								
	Honey-comb	*2*	–							
	Crepe	0.02	*2.02*	–						
Bamboo	Reverse	*1*	*3*	*0.98*	–					
	Honey-comb	0.03	*2.03*	0.01	*0.97*	–				
	Crepe	*2.02*	*4.02*	*2*	*1.02*	*1.99*	–			
Febran	Reverse	*2.03*	*4.03*	*2.01*	*1.03*	*2*	0.01	–		
	Honey-comb	*2.01*	*4.01*	*1.99*	*1.01*	*1.98*	0.01	0.02	–	
	Crepe	*5*	*7*	*4.98*	*4*	*4.97*	*2.98*	*2.97*	*2.99*	–

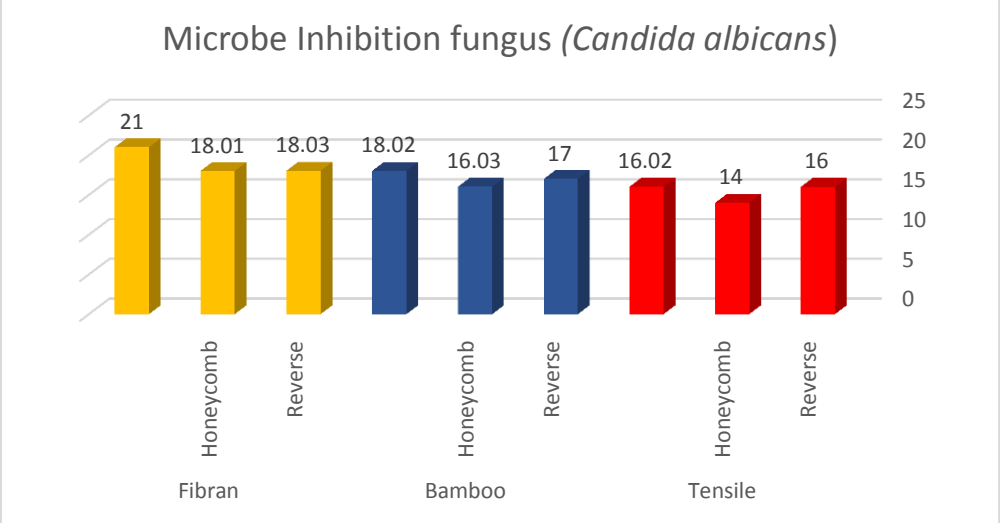

Figure (8): Averages of the raw materials treated with silver nanoparticles for the the weaving constructions in the test of microbe inhibition fungus (Candida albicans).

It is clear from table (18) and figures (8) showed that:

1- There are statistically significant differences at the level of (0.01) differences between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the microbe inhibition fungus test (Candida albicans). Febran Crepe comes in the first place, followed by Reverse Febran, Bamboo Crepe, Febran Honeycomb, Reverse Bamboo, Bamboo Honeycomb, Tinsel Crepe, Reverse Tinsel, and Tinsel Honeycomb, respectively.

2- There are no differences between Reverse Tinsel and Tinsel Crepe, while there are no differences between Reverse Tinsel and Bamboo Honeycomb. Furthermore, there are no differences between the following: Tinsel Crepe and Bamboo Honeycomb, Bamboo Crepe and Reverse Febran, and Bamboo Crepe and Febran Honeycomb, and Reverse Febran and Febran Honeycomb.

It can be concluded from tables (17 & 18) and figure (8) showed that weaving construction "Crepe" ranks first in the resistance to *Candida albicans* with a value of (21). This can be attributed to the few intersections in the Crepe tissues and its resistance to microbes, and its resistance increased by treatment with silver nanoparticles, followed by Reverse Febran with a value of (18),

and Tinsel Honeycomb comes in the last order with the lowest value, which is (14).

Table (19) Analysis of variance for the mean scores of raw materials treated with silver nanoparticles for weaving constructions on the test of microbe inhibition fungus (*Aspergillus Niger*).

Microbe inhibition fungus *(Aspergillus niger)*	Sum of Squares	Mean Squares	Degree of Freedom	F- Value	Sig.
Between Groups	107.881	13.485	8	40.455	0.01 Sig.
Within Groups	6.000	0.333	18		
Total	113.881		26		

It can be noted from table (19) showed that the value of (F) is (40.455), which is statistically significant at the level of (0.01), and this indicates that there are differences between the scores of raw materials “Tinsel , Bamboo, Febran ” in the treatment with silver nanoparticles for weaving constructions "Renverse, Honeycomb, Crepe" on the test of microbe inhibition fungus *(Aspergillus niger*). To find out the direction of significance, the LSD test for multiple comparisons was applied and the following table shows that:

Table (20): LSD Multiple Comparison Test

Microbe inhibition fungus *(Aspergillus niger)*		Tinsel			Bamboo			Febran		
		Reverse M= 14.00	Honey-comb M= 14.01	Crepe M= 16.00	Reverse M= 15.00	Honey-comb M= 17.00	Crepe M= 18.00	Reverse M= 17.02	Honey-comb M= 19.00	Crepe M= 20.00
Tinsel	Reverse	–								
	Honey-comb	0.01	–							
	Crepe	**2	**1.99	–						

Bamboo	Reverse	**1	*0.99	**1	-				
	Honey-comb	**3	**2.99	**1	**2	-			
	Crepe	**4	**3.99	**2	**3	**1	-		
Febran	Reverse	**3.02	**3.01	**1.02	**2.02	0.02	*0.98	-	
	Honey-comb	**5	**4.99	**3	**4	**2	**1	**1.98	-
	Crepe	**6	**5.99	**4	**5	**3	**2	**2.98	**1	-

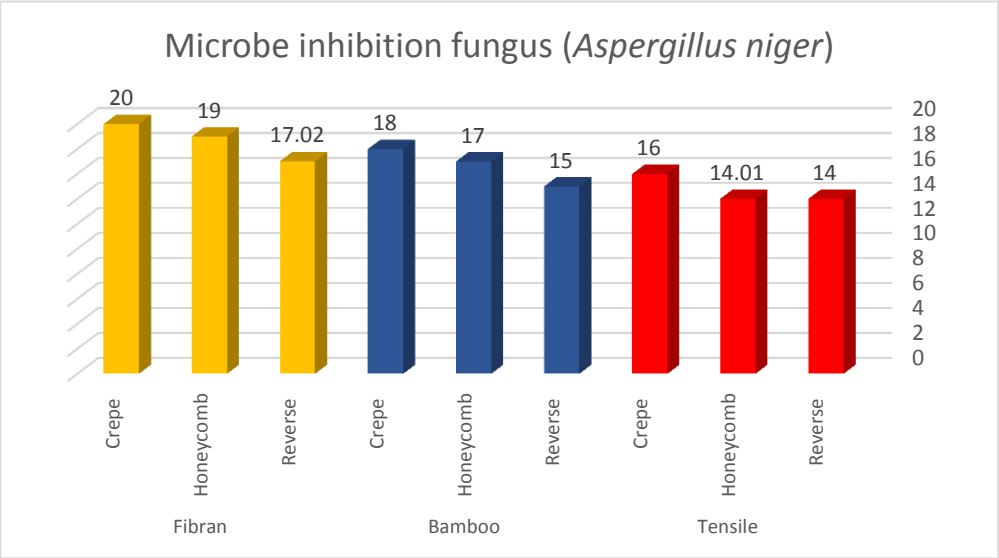

Figure (9): Averages of the raw materials treated with silver nanoparticles for the the weaving constructions in the test of microbe inhibition fungus (*Aspergillus niger).*

It is clear from table (20) and figures (9) showed that:

1- There are statistically significant differences at the level of (0.01) between the raw materials "Tinsel, Bamboo, and Febran" in the treatment with silver nanoparticles for the weaving construction "Renverse, Honeycomb, Crepe" on the test of microbe inhibition fungus (*Aspergillus Niger*). Febran Crepe comes in the first place, followed by Febran Honeycomb, Bamboo Crepe, Reverse Febran, Bamboo Honeycomb, Tinsel Crepe, Reverse Bamboo, Tinsel Honeycomb, and Reverse, respectively.

2- There are also differences at the significance level of (0.05) between Tinsel Honeycomb and Reverse Bamboo in favor of Reverse Bamboo. In addition, differences at the level of significance of (0.05) were found between Bamboo Crepe and Reverse Febran in favor of Bamboo Crepe.

3- There are no differences between Reverse Tinsel and Tinsel Honeycomb, while there are no differences between Bamboo Honeycomb and Reverse Febran.

It can be concluded from tables (19 & 20) and figure (9) showed that the Febran material with the weaving construction "Crepe" is in the first place with a value of (20) with a concentration of 750 m/L of silver nanoparticles, as the silver nanoparticles have a large surface area, increasing the chances of microbe contact with them. Therefore, it is effective in exterminating microbes, followed by the Febran Honeycomb in the resistance to the microbe "*Aspergillus niger*".

Assessment of the total quality of the produced fabrics used in the research:

This part includes a comparison of the results of laboratory tests for the treated fabrics under study with the standard sample, as follows:

- Comparing the quality of the fabrics produced using the material (Tinsel, Bamboo, and Febran) with the weaving constructions (Reverse, Honeycomb, and Crepe).

- comparing the treatment substance (silver nanoparticles) with the standard sample

A total assessment of the quality of the fabrics produced in this study was made for their suitability to their functional performance in order to select the best type of treatment substance, concentration of the treatment substance, then using multi-axis radar charts to show the assessment of the total quality of the fabrics produced. The following properties were used:

1. Ultraviolet rays (0).
2. Tensile strength (kg).
3. Elongation (%).
4. Weight (g/m2).
5. Absorption time (sec.).
6. Resistance to bacterial growth (mm).

The results of these properties measurements were converted into relative comparative values (without units) ranging from (zero: 100) as:

• the larger value is better for the tests of (Tensile strength, elongation, UV rays, and bacteria resistance).

• the lower value is the best for the tests of (weight and absorption time).

Table (21): Comparison of the assessment of the quality of the fabrics produced in this study using the raw material (Tinsel) and the treatment substance (silver nanoparticles) with the standard sample for the tests under study

Sample No.	Weaving Construction	Treatment substance Concentration (gm/liter)	UPF (%)	Tensile strength (%)	Elongation (%)	Weight (g/m2)	Absorption time (sec.)	Microbe inhibition fungus (%)				Total quality factor (%)	Order
								Gm +Ve *Staphylococcus aureus*	Gm -Ve *Escherichia coli*	*Candida albicans*	*Aspergillus niger*		
B	Reverse	-	4.468	54.15	40.23	99.41	95.56	0	0	0	0	32.65	12
1		250	57.45	88.685	47.904	95.7295	95.556	60	65	57.14	65	70.2738	6
2		500	70.21	90.2	48.404	93.1198	97.778	70	70	61.9	70	74.6244	3
3		750	82.98	44.014	47.353	95.8482	97.778	75	80	76.19	70	74.3513	5
B	Honeycomb	-	5.319	78.63	34.82	100	95.56	0	0	0	0	34.92	10
4		250	59.57	43.129	48.36	97.6275	97.778	65	65	57.14	65	66.5124	9
5		500	76.6	41.882	44.603	95.6109	97.778	70	70	61.9	65	69.2638	7
6		750	93.62	93.015	41.463	83.3926	97.778	75	75	66.67	70	77.3258	1
B	Crepe	-	4.681	67.57	41.95	94.66	97.78	0	0	0	0	34.07	11
7		250	65.96	44.309	56.64	88.7307	97.778	60	65	61.9	70	67.8133	8
8		500	87.23	44.202	57.265	91.9336	97.778	75	70	66.67	80	74.4532	4
9		750	97.87	43.639	60.368	85.7651	97.778	75	75	76.19	80	76.8458	2

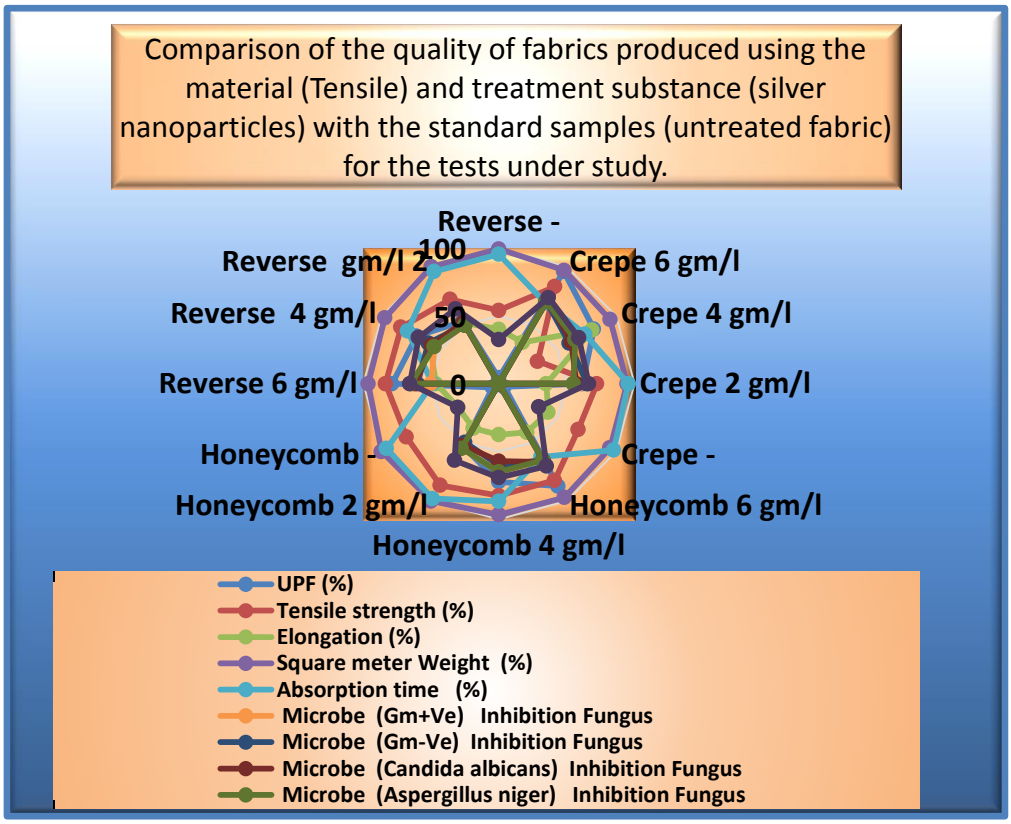

Figure (10): Comparison of the quality of fabrics produced using the material (Tinsel) and treatment substance (silver nanoparticles) with the standard samples (untreated fabric) for the tests under study.

It can be concluded from table (21) and figure (10) showed that, as for the fabric implemented using the material (Tinsel) and the treatment substance (silver nanoparticles), it was found that the fabric with the weaving connstruction (Honeycomb) treated with a concentration of (750 g/L) is the best with a quality factor of (77.33%), followed by the fabric with the weaving connstruction (Crepe) treated with a concentration of (750 g/L) with a quality factor of (76.85%), the fabric with the weaving connstruction (Reverse) treated with a concentration of (500 g/L) with a quality factor of (74.62%), the fabric with the weaving connstruction (Crepe) treated with a concentration of (500 g/L) with a quality factor of (74.45%), the fabric with the weaving connstruction

(Reverse) treated with a concentration of (750 g/L) with a quality factor of 74.35%, the fabric with the weaving connstruction (Reverse) treated with a concentration of (250 g/L) with a quality factor of (70.27%), the fabric with the weaving connstruction (Honeycomb) treated with a concentration of (500 g/L) with a quality factor of (69.26%), the fabric with the weaving connstruction (Crepe) treated with a concentration of (250 g/L) with a quality factor of (67.81%), the fabric with the weaving connstruction (Honeycomb) treated with a concentration of (250 g /liter) with a quality factor of (66.51%), the fabric with the untreated weaving construction (Honeycomb) with a quality factor of (34.92%), the fabric with the untreated weaving construction (Crepe) with a quality factor of (34.07%), and the fabric with the untreated weaving construction (Reverse) with a quality factor of (32.65%), respectively.

Table (22): Comparison of the assessment of the quality of the fabrics produced in this study using the raw material (Bamboo) and the treatment substance (silver nanoparticles) with the standard sample for the tests under study

Sample No.	Weaving Construction	Treatment substance Concentration (gm/liter)	UPF (%)	Tensile strength (%)	Elongation (%)	Weight (g/m2)	Absorption time (sec.)	(%)Microbe inhibition fungus				Total quality (%) factor	Order
								Gm ve+ *Staphylococcus aureus*	Gm ve− *Escherichia coli*	*Candida albicans*	*Aspergillus niger*		
B	Reverse	–	4.894	37.82	45.85	83.99	93.33	0	0	0	0	29.54	12
10		250	57.45	41.185	48.846	79.3594	95.556	65	70	66.67	70	66.0066	9
11		500	85.11	36.077	46.338	77.6987	97.778	75	75	71.43	70	70.4919	8
12		750	89.36	40.126	48.235	81.6133	97.778	80	85	80.95	75	75.3407	5
B	Honeycomb	–	5.532	67.3	37.65	79.83	96.67	0	0	0	0	31.89	11
13		250	61.7	91.232	40.279	82.2064	97.778	70	75	66.67	70	72.7627	6
14		500	78.72	88.283	49.713	77.6987	97.778	75	85	66.67	75	77.0958	4
15		750	95.74	88.886	40.022	72.7165	97.778	80	90	76.19	85	80.7042	2
B	Crepe	–	5.957	65.81	42.7	85.41	97.78	0	0	0	0	33.07	10
16		250	61.7	99.678	43.515	78.6477	97.778	60	70	61.9	75	72.025	7
17		500	82.98	93.377	38.294	77.4614	97.778	80	80	71.43	85	78.4798	3
18		750	95.74	91.809	37.206	70.5813	97.778	85	85	85.71	90	82.0925	1

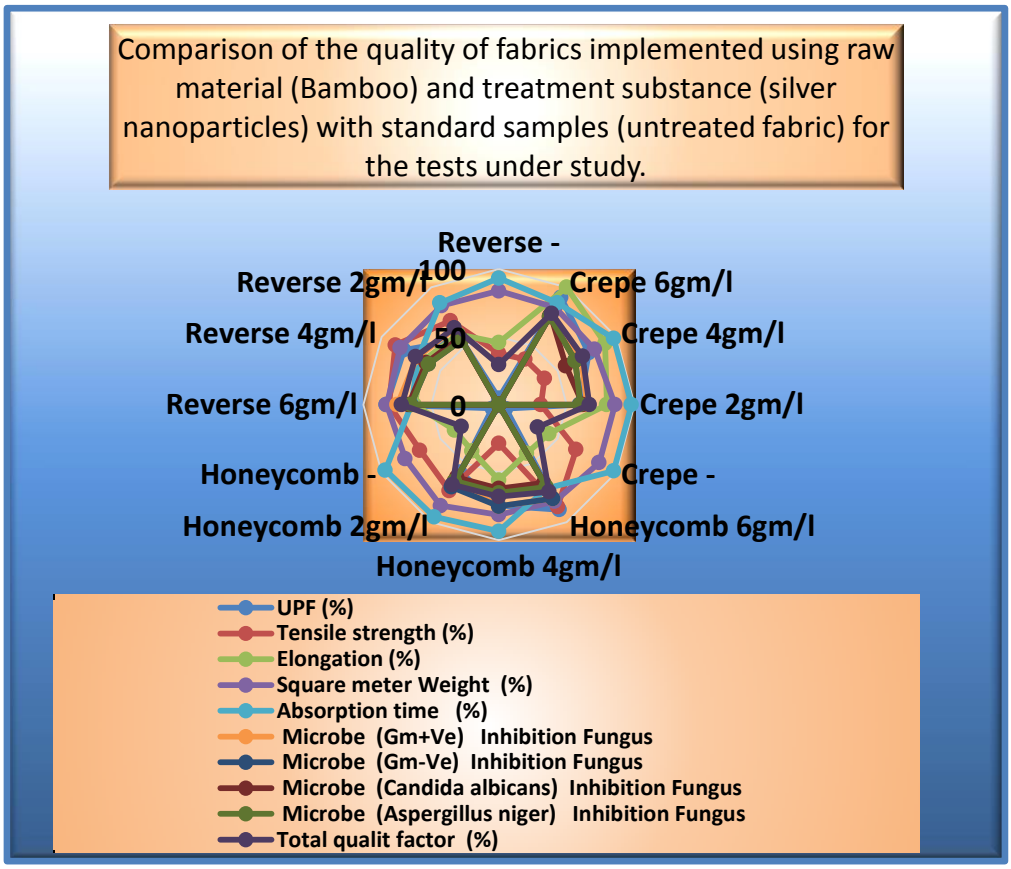

Figure (11): Comparison of the quality of fabrics implemented using raw material (Bamboo) and treatment substance (silver nanoparticles) with standard samples (untreated fabric) for the tests under study.

It can be can conclude from table (22) and figure (11) showed that, as for the fabric implemented using the raw material (Bamboo) and the treatment substance (silver nanoparticles), we find that the fabric with the weaving connstruction (Crepe) treated using a concentration of (750 g / liter) is the best with a quality factor of (82.09%), followed by the fabric with the weaving connstruction (Honeycomb) treated using a concentration of (750 g/L) with a quality factor of (80.7%), the fabric with the weaving connstruction (Crepe) treated using a concentration of (500 g/L) with a quality factor of (78.48%), the fabric with the weaving connstruction (Honeycomb) treated using a concentration of (500 g/L) with a quality factor of (77.1%), the fabric the weaving

connstruction (Reverse) treated using a concentration of (750 g/L) with a quality factor of (75.34%), the fabric with the weaving connstruction (Honeycomb) treated using a concentration of (250 g/L)) with a quality factor of (72.76%), the fabric with the weaving connstruction (Crepe) treated using a concentration (250 g/L) with a quality factor of (72.025%), the fabric with the weaving connstruction (Reverse) treated using a concentration (500 g/L) with a quality factor of (70.49%), the fabric with the weaving connstruction (Reverse) using a concentration of (250 g/L) with a quality factor of (66.01%), the fabric with the untreated weaving connstruction (Crepe) with a quality factor of (33.07%), the fabric with the untreated weaving connstruction (Honeycomb) with a quality factor of (31.89%), and the fabric with the untreated weaving connstruction (Reverse) with a quality factor of (29.54%), respectively

Table (23): Comparison of the assessment of the quality of the fabrics produced in this study using the raw material (Febran) and the treatment substance (silver nanoparticles) with the standard sample for the tests under study

Sample No.	Weaving Construction	Treatment substance Concentration (gm/liter)	UPF (%)	Tensile strength (%)	Elongation (%)	Weight (g/m2)	Absorption time (sec.)	(%)Microbe inhibition fungus				Total quality (%)factor	Order
								Gm ve+ *Staphylococcus aureus*	Gm ve− *Escherichia coli*	*Candida albicans*	*Aspergillus niger*		
B	Reverse	−	5.106	65.71	31.49	95.26	95.56	0	0	0	0	32.57	12
19		250	63.83	85.869	44.331	93.3571	95.556	70	70	76.19	75	74.9037	9
20		500	87.23	26.281	74.691	91.1032	97.778	80	85	76.19	75	77.0309	6
21		750	95.74	88.819	42.132	79.2408	97.778	85	85	85.71	85	82.7143	4
B	Honeycomb	−	5.745	85.82	30.99	95.26	97.78	0	0	0	0	35.07	10
22		250	61.7	89.958	39.213	90.1542	95.556	75	80	71.43	80	75.8902	7
23		500	87.23	86.942	41.838	79.1222	97.778	80	85	76.19	80	79.345	5
24		750	97.87	74.889	34.118	83.1554	97.778	85	100	85.71	95	83.7252	2
B	Crepe	−	6.17	81.82	28.62	92.88	95.56	0	0	0	0	33.89	11
25		250	65.96	93.149	37.044	89.3238	97.778	65	75	71.43	85	75.5201	8
26		500	87.23	95.656	38.993	86.121	97.778	85	90	76.19	95	83.5525	3
27		750	100	97.748	39.287	79.2408	100	95	100	100	100	90.1417	1

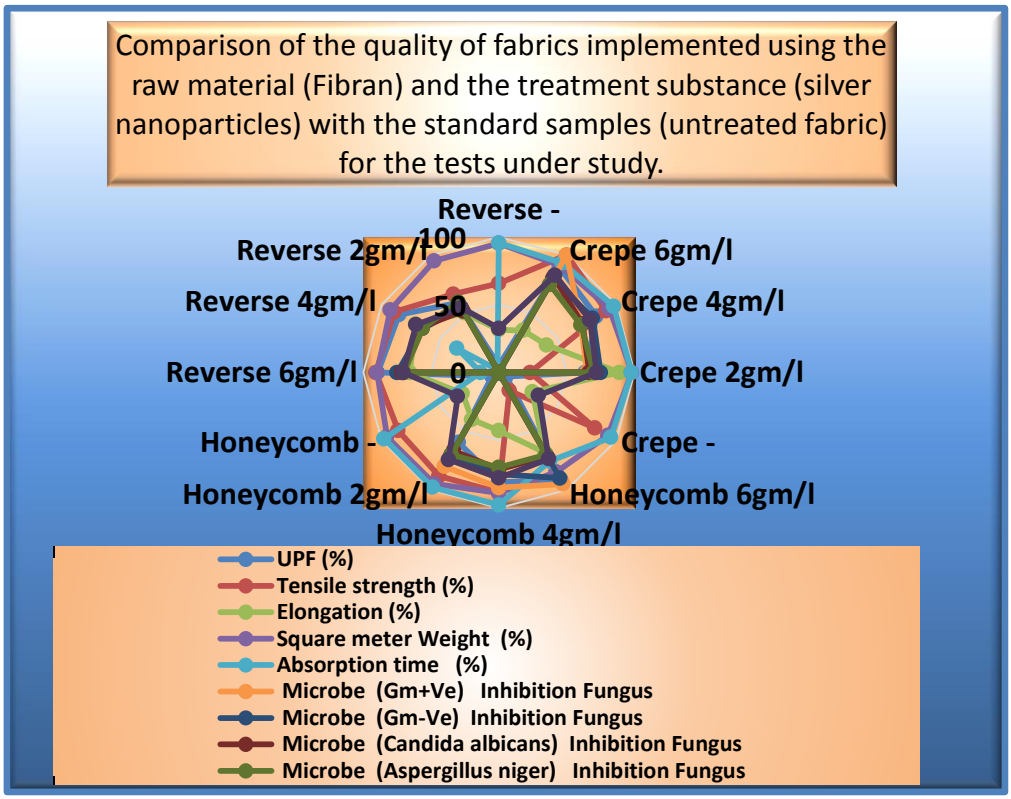

Figure (12):Comparison of the quality of fabrics implemented using the raw material (Febran) and the treatment substance (silver nanoparticles) with the standard samples (untreated fabric) for the tests under study.

It can be can conclude from table (22) and figure (11) showed that, as for the fabric implemented using the raw material (Febran) and the treatment substance (silver nanoparticles), we find that the fabric with with the weaving connstruction (Crepe) treated using a concentration of (750 g / liter) is the best with a quality factor of (90.14%), followed by the fabric with with the weaving connstruction (Honeycomb) treated using a concentration of (750 g/L) with a quality factor of (83.73%), the fabric with the weaving connstruction (Crepe) treated using a concentration of (500 g/L) with a quality factor of (83.55%), the fabric with with the weaving connstruction (Reverse) treated using a concentration of (750 g/L) with a quality factor of (82.71%), the fabric with with the weaving connstruction (Honeycomb) treated using a concentration of (500 g/L) with a quality factor of (79.35%), the fabric with with the weaving connstruction (Reverse) treated using a concentration of (500 g/L) with a quality factor of (77.03%), the fabric with with

the weaving connstruction (Honeycomb) treated using a concentration of (250 g/L) with a quality factor of (75.89%), the fabric with the weaving connstruction (Crepe) treated using a concentration of (250 g/L) with a quality factor of (75.52%), the fabric with the weaving connstruction (Reverse) treated using a concentration of (250 g/L) with a quality factor of (74.9%), the fabric with the untreated weaving connstruction (Honeycomb) with a quality factor of (35.07%), the fabric with the untreated weaving connstruction (Crepe) with a quality factor of (33.89%), and the fabric with the untreated weaving connstruction (Reverse) with a quality factor of (32.57%), respectively

Table (24): Ranking of the total quality of the fabric samples under study

Sample No.	Treatment Substance	Material	Weaving Construction	Treatment Substance Consontration	Total Quality Factor	Rank
27	silver nanoparticles	Febran	Crepe	750 g/L	90.1417	1
24	silver nanoparticles	Febran	Honeycomb	750 g/L	83.72521	2
26	silver nanoparticles	Febran	Crepe	500g/L	83.55247	3
21	silver nanoparticles	Febran	Reverse	750 g/L	82.71431	4
18	silver nanoparticles	Bamboo	Crepe	750 g/L	82.09249	5
15	silver nanoparticles	Bamboo	Honeycomb	750 g/L	80.70415	6
23	silver nanoparticles	Febran	Honeycomb	500g/L	79.34496	7
17	silver nanoparticles	Bamboo	Crepe	500g/L	78.47975	8
6	silver nanoparticles	Tinsel	Honeycomb	750 g/L	77.32583	9
14	silver nanoparticles	Bamboo	Honeycomb	500g/L	77.09582	10
20	silver nanoparticles	Febran	Reverse	500g/L	77.03085	11
9	silver nanoparticles	Tinsel	Crepe	750 g/L	76.84577	12
22	silver nanoparticles	Febran	Honeycomb	250g/l	75.89024	13
25	silver	Febran	Crepe	250g/l	75.52011	14

Sample No.	Treatment Substance	Material	Weaving Construction	Treatment Substance Consontration	Total Quality Factor	Rank
	nanoparticles					
12	silver nanoparticles	Bamboo	Reverse	750 g/L	75.34072	15
19	silver nanoparticles	Febran	Reverse	250g/l	74.90369	16
2	silver nanoparticles	Tinsel	Reverse	500g/L	74.62437	17
8	silver nanoparticles	Tinsel	Crepe	500g/L	74.45316	18
3	silver nanoparticles	Tinsel	Reverse	750 g/L	74.35134	19
13	silver nanoparticles	Bamboo	Honeycomb	250g/l	72.76272	20
16	silver nanoparticles	Bamboo	Crepe	250g/l	72.02503	21
11	silver nanoparticles	Bamboo	Reverse	500g/L	70.49188	22
1	silver nanoparticles	Tinsel	Reverse	250g/l	70.27378	23
5	silver nanoparticles	Tinsel	Honeycomb	500g/L	69.26383	24
7	silver nanoparticles	Tinsel	Crepe	250g/l	67.81326	25
4	silver nanoparticles	Tinsel	Honeycomb	250g/l	66.51245	26
10	silver nanoparticles	Bamboo	Reverse	250g/l	66.00658	27

We can conclude from table (24) showed that the best fabric in achieving the functional performance properties of the fabrics produced in this research is the fabric made of Febran material and the weaving construction "Crepe" treated using (silver nanoparticles) with a concentration of (750 g/L) with a quality factor of (90.1417%) for all the various tests, whereas the least fabric in achieving the functional performance properties of the fabrics produced in this research is the Bamboo with the weaving construction "Reverse" treated with silver nanoparticles at a concentration of (250 g/L) with a quality factor of (66.00658).

Results

1-Febran with the weaving construction "Crepe" at a concentration of (750 g/liter) achieved the highest results for all tests with a quality factor of (90.1417%).

2- Febran Crepe treated with nano silver achieved the highest results in resistance to (UPF), resistance to both Gram-positive and Gram-negative bacteria, and resistance to both Aspergillus niger and Candida albicans.

3- Silver nanoparticles have an effect on the weight, thus we note that Bamboo Crepe and Bamboo Honeycomb, followed by Febran Crepe achieved the highest results in weight as a result of the treatment with silver nanoparticles.

4- Bamboo Honeycomb and Tinsel Honeycomb achieved the highest results in absorption time, while Tinsel Crepe had lowest results.

5- Reverse Febran achieved the highest value in the elongation ratio, followed by Tinsel Crepe, and Febran Crepe came in the last order with the lowest elongation rate.

Recommendations:

1. Adding educational content on treating textile with different types of weaving constructions for the Department of Home Economics, specializing in clothing and textile.
2. Keeping pace with modern developments and benefiting from nanotechnology in obtaining safe textiles by using eco-friendly substances that do not cause any harm to health.
3. Conducting more studies related to the preparartion of cotton fabrics to give them new characteristics so that they can compete in the global market.

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