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الخصائص الوظيفية للأقمشة القطنية المعالجة بالكربون المنشط المنتج من نوى البلح المصري

Functional properties of cotton fabrics treated with activated carbon prepared from Egyptian date nucleus

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Abstract:

At present textiles are mainly focused and developed for their performance in various fields. Therefore, activated carbon produced from Egyptian date nuclei was used to improve some properties of cotton fabrics. This is due to its characteristics such as antimicrobial and Odor control with low cost (1). Where the date nucleus is considered one of the main wastes for the manufacture of dates for human consumption, as the manufacture of evaporated dates, or the distillation of dates to obtain wines, as in some countries that produce dates in large quantities. The world produces more than 96 million date palms. Where the date nucleus represents about 10% of the fruit. (2) Thus, the amount of nucleus left over from the manufacture of dates is very large and is not used in most countries. Therefore, this research paper aims to present how activated carbon is produced from date nucleus and how to apply it to cotton fabrics, in addition to studying the modified properties on cotton fabrics after placing activated carbon over them. The activated carbon in powder form was prepared by chemical activation with zinc chloride and to obtain CZ21. Three different types of cotton fabrics were used, and they were treated with three different concentrations of activated carbon powder. Finished Cotton fabrics are assessed the effectiveness of the anti- microbial property through disc diffusion method which against the microorganisms of (Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans, Aspergillus Niger). The cotton fabrics treated with activated carbon showed good functional properties.

Key words: Activated Carbon, date nucleus, cotton fabrics, Anti- Microbial Property.

1. Introduction

moved the textile industry in the direction of producing more innovative, functional fabrics with high quality standards. Where the textile industry faces major challenges. (3) The textile finishing process is one of the main factors that determine the desired effects of the product final consumption. Textile finishing has emerged as a sector important anti-microbial market includes consumer and technical products for health care and hygiene control. Indicate infection in hospitals and surface contamination, which includes micro-organisms to the importance of finishing anti-microbial. The final antimicrobial textiles are required to reduce the growth and transmission of micro-organisms. [4] Consumers are now aware of the increasingly healthy lifestyle and necessity and their expectations for a wide range of textile products. As the normal human body secretes a daily amount of sweat to get rid of some toxins in the body that cause unpleasant odors because of the growth of microbes. [5] Activated carbon containing different functional groups on the surface can be used in different applications [1]. Carbon is generally known for its excellent properties through a wide range of applications. Solvent extraction of removable odorless coloring materials and gases from water based. Activated carbon having different functional groups on the surface can be used for various applications. The first recorded use of carbon for medicinal purposes comes from Egyptian papyri around 1500 B.C. The principal use appears to have been to adsorb the unpleasant odors from putrefying wounds tract. [6], [1] The activation of charcoal modifies the internal structure of the carbon atom such as increasing the surface area of the carbon atom or reducing the pore size. Activated carbon with increased pore size will trap toxins and chemicals and prevent further absorption, besides the negative electric charge of these pores will attract all positively charged particles (toxins and gases). The properties of activated carbon can be infused into textile fields or into textile materials. [7] This study is aimed to present how activated carbon is produced from date nucleus and how to apply it to cotton fabrics, in addition to studying the modified properties on cotton fabrics after added activated carbon over them.

2. Materials and Methods.

- Activated carbon.
- Cotton fabrics.

2.1 Activated carbon

2.1.1 Definition of active charcoal molecule

Active carbon molecule is a form of carbon with a large surface area and is an amorphous solid with a high porosity that contains fine grains، especially to make it porous. Activated carbon is prepared in the form of small granules or

fine powder, Activated charcoal is a non-polar material and is also expensive, reaching $15,000 per ton. It is imported by Arab countries and not produced in them. Egypt alone consumes nearly 6000 tons per month, and its main source is China. [2]

2.1.2 Preparation of activated carbon from date nucleus

The date nucleus was collected and washed well with hot water to get rid of the impurities sticking to it, then dry it at a temperature of 110° for 24 hours and crushing to a particle size of 2 mm. Then the date nuclei were immersed in zinc chloride (1:2). For 24 hours, this process is called chemical activation Thus, CZ21 was obtained. After that, it is dried in the oven and then the raw materials are heated to get rid of the other materials and any emerging gases and liberate them. The process of heating at a temperature of 550 ° C in isolation from the air for three hours without burning coal, then cooling and storing in clean sealed bottles. Fig 1. Raw date nucleus. Fig 2. date nucleus after washing, crushing, and drying, Fig 3. Date nucleus after burning and converting to activated carbon.

Fig 1. Raw date

Fig 2. The date nucleus after washing, crushing, and

Fig3. Date nucleus after burning and converting to activated carbon

- Characterization of the prepared activated carbon

A- ash content, the ash content by weighing the sample before burning and then placing it in the oven for 6 hours at a temperature of 650º. We leave the sample to cool. Then we weigh it again.

B- Weight loss drying, Samples are weighed and then placed in an oven at 105° for 24 hours, then samples are weighed and the percentage of loss we get from the following law:

$$\text{Weight loss drying} = \frac{Wp - Wa}{Wp} \times 100$$

Where, Wp is the weight of sample before drying,

Wa is the weight of sample after drying

C- Power of Hydrogen (pH), 0.5 g was weighed and then placed in 25 ml of water and shaken for 48 hours, then the pH was determined.

D- surface area and pore size, Surface area and pore size distribution using ASAP 2020 by ISO 15901-3: 2007 Test Method. Table 1. Shows Characterization of the prepared activated carbon.

Table 1. Characterization of the prepared activated carbon

sample	**Percentage ash (%)**	**Weight loss drying (%)**	**pH**	**BET (specific surface area m^2/g)**	**pore size (nm)**
activated carbon (CZ21)	2.515	7.125	3.850	450.9	1.15

2.2 cotton fabrics

use of three types of cotton fabrics, two samples are weaving cotton fabrics, and one sample is knitting cotton fabrics. Table 2. Shows Characterization Of woven cotton fabrics, Table 3. Shows Characterization Of knitting cotton fabrics.

Table 2. Characterization of the woven fabrics

sample number	Material	structure	Warp yarn type	Weft yarn type	Yarn count / warp	Yarn count / weft	Warp density/cm^2	Weft density/cm^2	weight (g/m^2)	Thickness (mm)
1	100% cotton gauze	Plain 1/1	Twisted cotton	Twisted cotton	20/1	25/1	16	13	83	0,36
2	100% cotton woven	Plain 1/1	single cotton	single cotton	30	33	27	23	101	0,38

Table 3. Characterization of the knitting fabrics

sample number	Material	structure	Column/inch	Yarn count Metric	weight (g/m^2)	Thickness (mm)
3	Cotton core spun lycra	Single jersey	34	4500	207	0,88

2.3 activated carbon Powder Loading on Cotton Fabrics

Cotton fabrics were washed, sterilized, and dried before use. The cotton fabrics were treated with activated carbon, using three different concentrations (1.5, 2, 2,5 g/l) and one concentration of Citric acid (8 g/l).

Activated carbon was mixed with citric acid in distilled water . Each sample was immersed separately in flask containing its own solution. All the flasks were placed at a temperature of 28°C with Shaking at 600 rpm for 24 hours to combine the activated carbon particles into the fabric. Table 4. Shows Material specification and treatment solution.

Table 4. Material specification and treatment solution

sample number	Material and structure	citric acid g/l	Concentrations activated carbon Powder g/l	PH	Temperature °C	Shaking rpm	treatment time (hours)	drying temperature (°C)
1	100% cotton gauze	8	1,5	3	28	600	24	60
2	Cotton core spun lycra knitting	8	1,5	3	28	600	24	60
3	100% cotton woven	8	1,5	3	28	600	24	60
4	100% cotton gauze	8	2	3	28	600	24	60
5	Cotton core spun lycra knitting	8	2	3	28	600	24	60
6	100% cotton woven	8	2	3	28	600	24	60
7	100% cotton gauze	8	2,5	3	28	600	24	60
8	Cotton core spun lycra knitting	8	2,5	3	28	600	24	60
9	100% cotton woven	8	2,5	3	28	600	24	60

3. Results and Dissections

Table 5. Summary of fabrics tests result before and after treatment

Sample number	Material and structure	Concentrations activated carbon Powder g/l	Antimicrobial Assessment - Zone of inhibition (mm)				Moisture Transmission Time (min)	Weight (g/m²)
			Staphylococcus aureus, G+ve	*Pseudomonas aeruginosa,*	*Candida albican*	*Aspergillus Niger*		
control	100% cotton gauze	-	0	0	0	0	22	83
control	Cotton core spun lycra knitting	-	0	0	0	0	68	206
control	100% cotton woven	-	0	0	0	0	35	101
1	100% cotton gauze	2	١3	13	14.5	١1	30	96
2	Cotton core spun lycra knitting	2	14	14	15.5	١3.5	72	250
3	100% cotton woven	2	13.5	13.5	15	11.5	41	107
4	100% cotton gauze	2.5	13	13	14.5	١٠	36	109
5	Cotton core spun lycra knitting	2.5	١4	15	15.5	١٣.5	77	292
6	100% cotton woven	2,5	13.5	13.5	15	١٣	45	113
7	100% cotton gauze	3	13	14.5	15.5	١٢	40	122
8	Cotton core spun lycra knitting	3	15	15.5	16.5	١٣.5	80	334
9	100% cotton woven	3	14	15	16	13	50	119

3.1 Antimicrobial Assessment Test

The Antimicrobial Method was adopted from a previous study by Abdel-Aziz MS et al. (2019) [(8)]. The agar plate method was used to evaluate the antimicrobial activities of untreated and treated textile samples. This disc diffusion test was done according to Collins and Lyne (1985). The antimicrobial activities of the textile specimens were tested against two bacterial test microorganisms (*Staphylococcus aureus,* G+ve bacteria and *Pseudomonas aeruginosa*, G-ve bacteria) and yeast test microbe (*Candida albicans*) as well as fungal test strain *Aspergillus Niger*. The bacterial and yeast test microbes were grown on nutrient agar (DSMZ1) medium (g/L): beef extract (3), peptone (10), and agar (20), whereas the fungal test strain was grown on Szapek-Dox (DSMZ130) medium (g/l): sucrose (30), $NaNO_3$ (3), $MgSO_4$.$7H_2$ O (0.5), KCl (0.5), Fe_2SO_3 .$7H_2O$ (0.001), K_2 HPO_4 (1) and agar (20).. The culture of each microorganism was diluted with sterile distilled water to 10^7–10^8 CFU/mL. Sample discs (10-mm diameter) were located on the surface of the agar plates (10-cm diameter containing 25 mL of solidified media). The discs were placed on inoculated agar plates and incubated for 24 h at 37°C and for 48h and at 30^o C for fungal test microbe. A corresponding plate without any discs was used as a negative control. An antimicrobial test on untreated textile was considered as a positive control. Sample antimicrobial activities were evaluated by the diameter of the clear zones that appeared around the discs (Abdel-Aziz et al., 2019).[8] The results were averaged. Fig 4. Antimicrobial Assessment of Staphylococcus aureus G$^+$ve bacteria by diameter of the clear zones that appeared around the discs of Treated Samples and control sample. The experiment was carried out more than once and mean of reading was recorded. Figures (4, 5, 6, 7) shows diameter of the clear zones that appeared around the discs of Treated Samples and control sample. Fig 4. antimicrobial Assessment of *Staphylococcus aureus G+ve* bacteria, Fig 5. Antimicrobial Assessment of *Pseudomonas aeruginosa, G-ve* bacteria, Antimicrobial Assessment of *Candida albicans* fungal, Fig 7. Antimicrobial Assessment of *Aspergillus Niger* fungal.

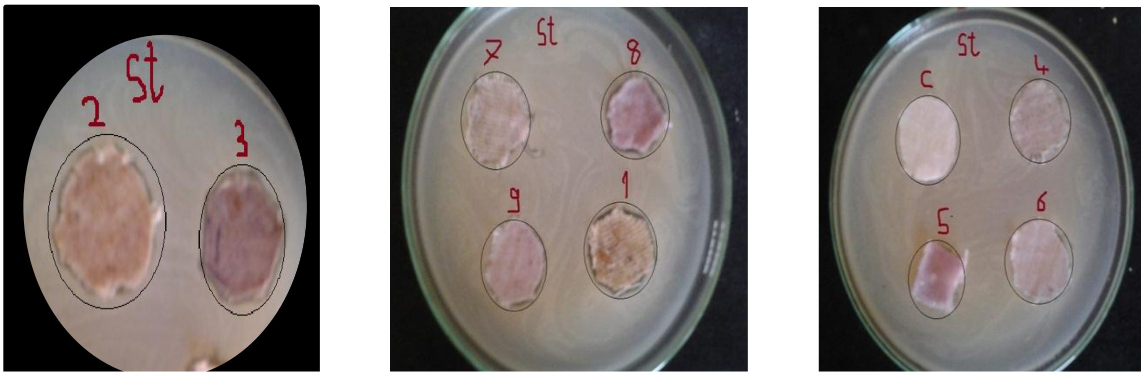

Fig 4. antimicrobial Assessment of *Staphylococcus aureus G+ve* bacteria by diameter of the clear zones that appeared around the discs of Treated Samples and control sample

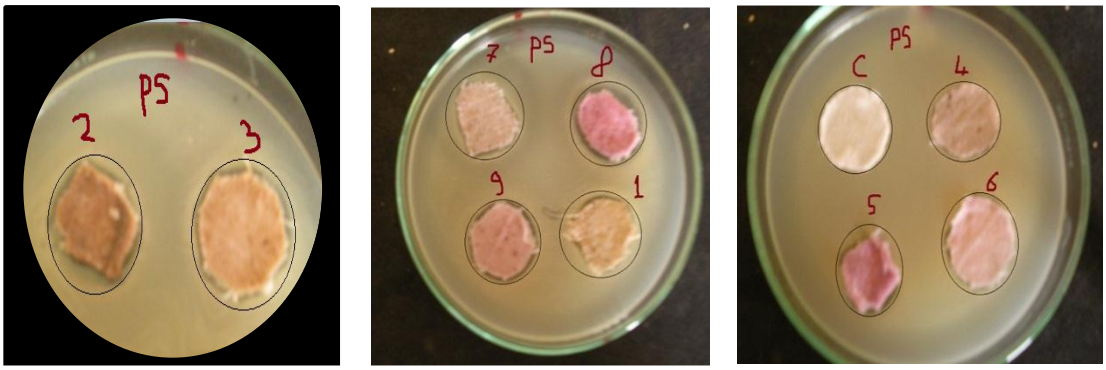

Fig 5. antimicrobial Assessment of *Pseudomonas aeruginosa, G-ve* bacteria by diameter of the clear zones that appeared around the discs of Treated Samples and control sample.

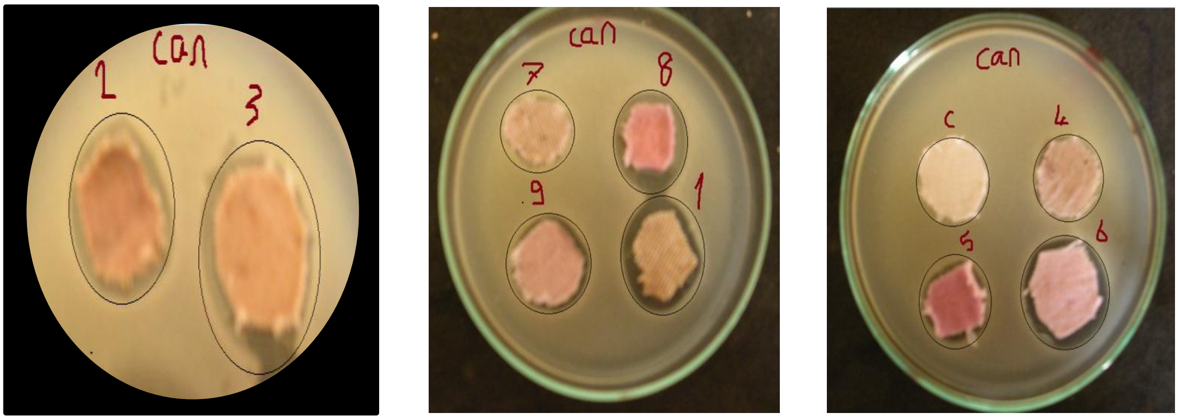

Fig 6. antimicrobial Assessment of *Candida albicans* fungal by diameter of the clear zones that appeared around the discs of Treated Samples and control sample

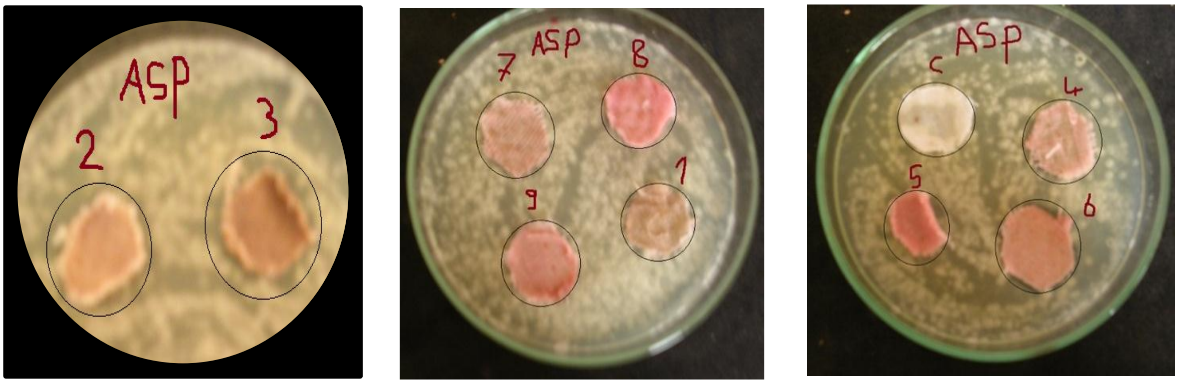

Fig 7. antimicrobial Assessment of *Aspergillus Niger* fungal by diameter of the clear zones that appeared around the discs of Treated Samples and control sample.

3-2 Effect of activated carbon concentration and fabrics Density on treated cotton fabrics on the resistance of (Staphylococcus aureus, G^{+}ve, Pseudomonas aeruginosa, G^{-} ve bacteria) and (Candida albicans, Aspergillus Niger Fungai)

Table 5. and chart Figures (8,9,10,11) shows Effect of activated carbon concentration and cotton fabrics Density treated on the resistance of bacteria and Fungi. Where we note that by increasing the concentration of activated carbon, the resistance of cotton fabrics to bacteria and fungi increases. We also note that as the density of fabrics increases, the resistance to bacteria and fungi increases. This may be because the higher the density of the fabrics, the more it can absorb a larger amount of the treatment material, and thus greater resistance to microbes.

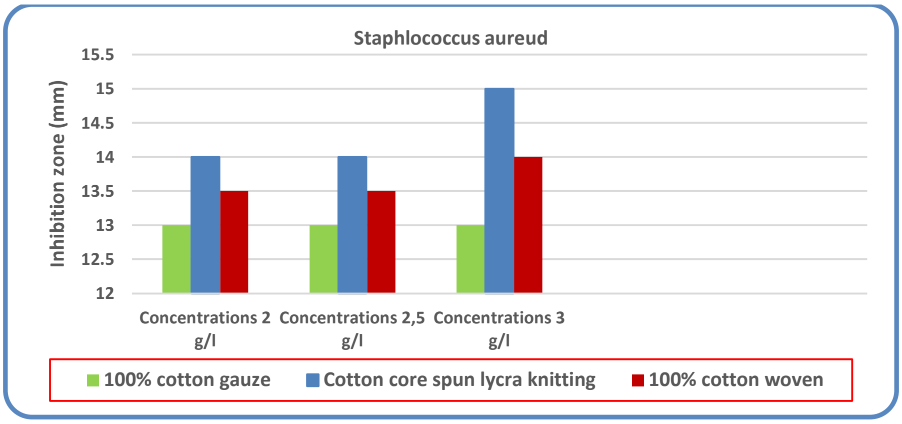

Fig 8. Effect of activated carbon concentration on the resistance of *Staphylococcus aureus* bacteria.

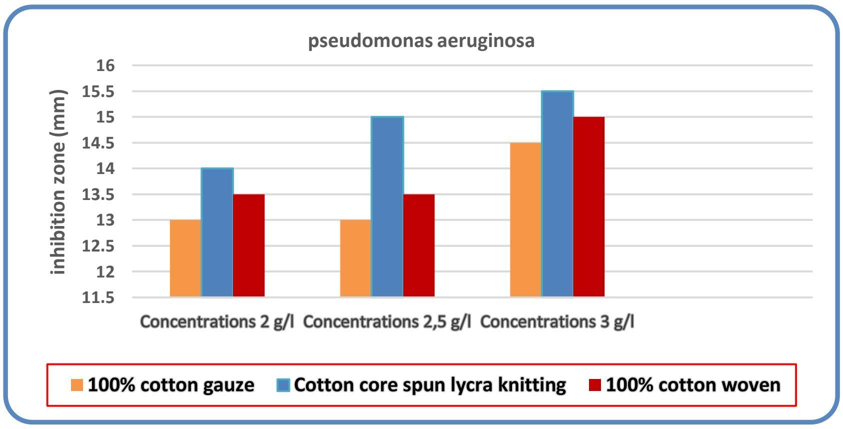

Fig 9. Effect of activated carbon concentration on the resistance of *Pseudomonas aeruginosa* bacteria.

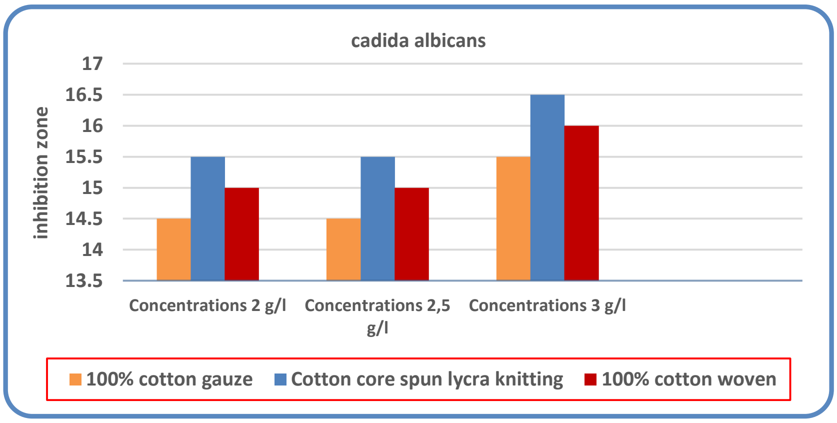

Fig 10. Effect of activated carbon concentration on the resistance of Candida albicans fungal.

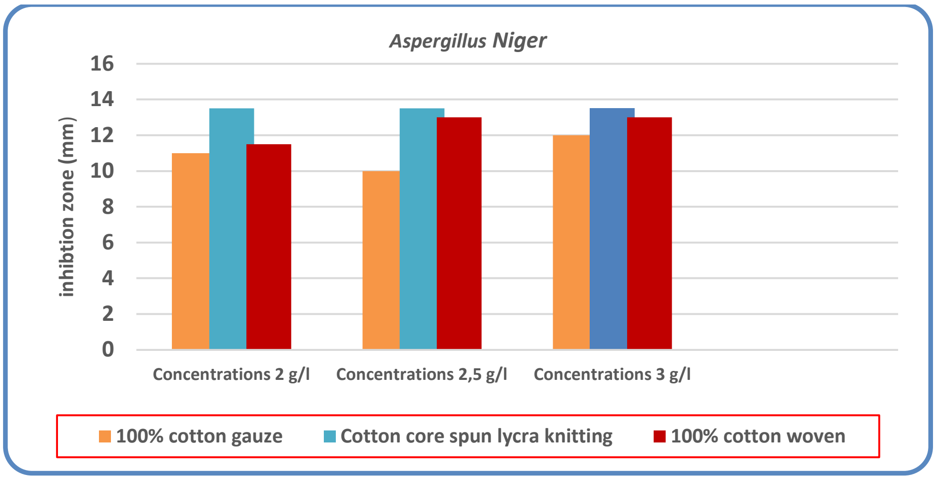

Fig 11. Effect of activated carbon concentration on the resistance of *Aspergillus Niger fungal.*

3-3 Test of specific requirements of moisture transferring and drying Textile

This test according to the Korean Standard (stts-sa-004). The test was conducted on fabric samples before treatment and after treatment with activated carbon, to verify the effect of different concentrations on of moisture transferring time and drying for treatment fabrics. Table 5. And Fig 12. shows Effect of activated carbon concentration on time of moisture transferring and drying Fabric. Where we notice that the increase in the concentration of active carbon increases the time required for the transfer of moisture and dehydration. The reason for this may be that the increase in the concentration of activated carbon inside the fabrics leads to a reduction in the pores and thus leads to an increase in the time required for moisture to transferring and to reach dryness.

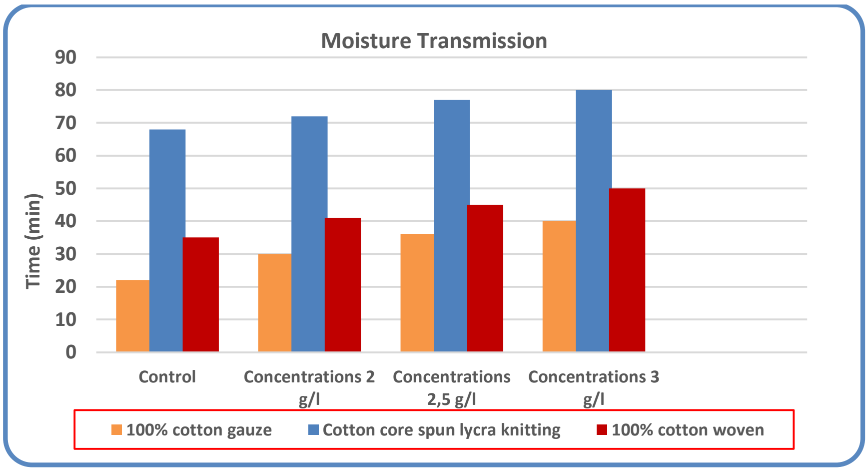

Fig 12. Effect of activated carbon concentration on time of moisture transferring and drying Fabrics

3- 4 Weight test

This test according to the (RS-232C) on a sensitive scale (EK-300i) [9]. The test was conducted on fabric samples before treatment and after treatment with activated carbon, to verify the effect of different concentrations on the Weight. Table 5. And Fig 13. shows Effect of activated carbon concentration on the square meter weight of fabrics. Where we notice that the increase in the concentration of active carbon increases fabrics weight. This may be due to nature of the cotton fabrics in their high absorbency.

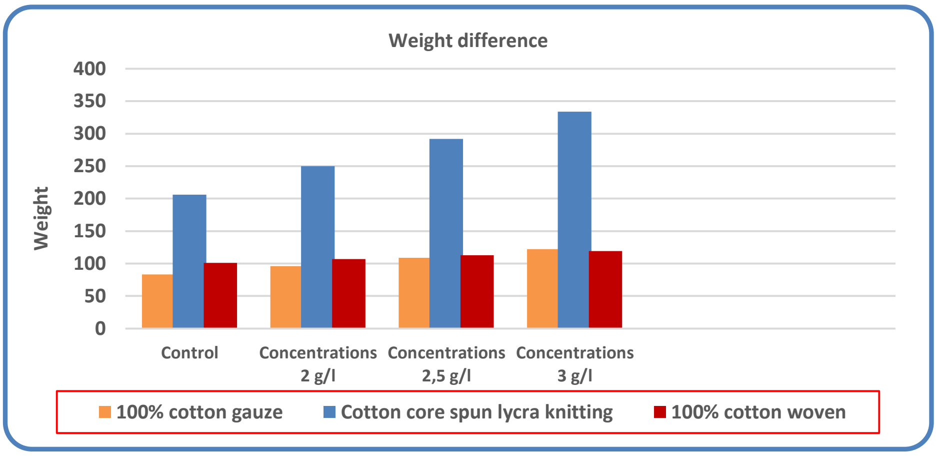

Fig 13. Effect of activated carbon concentration on

4- Conclusions

1- The possibility of converting dates nucleus into activated carbon and benefiting from it in many industries, including the textile industries. Rather than dispose of it in a polluting way for the environment.

2- The cotton fabrics treated with activated carbon produced from dates nucleus showed good resistance to various microbes, (Staphylococcus aureus, G^{+}ve, Pseudomonas aeruginosa, G^{-} ve bacteria) and (Candida albicans, Aspergillus Niger Fungai).

3- Fabrics treated with activated carbon produced from dates nucleus showed a small increase in the time required for moisture transfer.

5. References

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the quality of some types of medical clothing" Journal of Applied Art and Science - International Periodical Scientific Peer Reviewed - Issued by Faculty of Applied Arts - Damietta University. – Egypt. (ISSN 2537-1061) 2018 (Print) (ISSN 2537-107X) (Online)

فيروز أبو الفتوح الجمل، رشا عبد المعطى محمود أحمد، تأثير قابلية الحياكة للأقمشة "آيات أحمد يوسف أبو فراج "غير المنسوجة على جودة بعض أنواع الملابس الطبية مجلة الفنون والعلوم التطبيقية، كلية الفنون التطبيقية، المجلد الخامس العدد الثاني أبريل ٢٠١٨ جامعة دمياط

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ملخص البحث: -

في الوقت الحاضر تركز المنسوجات الوظيفية بشكل أساسي على تطوير أدائها في شتي المجالات. ولذلك فقد تم استخدام الكربون المنشط المنتج من نوى البلح المصري في تحسين بعض خواص الاقمشة القطنية. وذلك لما يتميز به من خواص مثل مقاومة الميكروبات والتحكم في الروائح مع التكلفة المنخفضة (١). حيث يعتبر نوى البلح أحد المخلفات الرئيسية لتصنيع البلح للاستهلاك الآدمي، حيث انه المخلف عند صناعة البلح المبخر او تقطير البلح للحصول على الخمور كما في بعض البلاد المنتجة للبلح بكميات كبيرة. حيث ينتج العالم أكثر من٩٦ مليون نخلة تقريبًا. حيث يمثل نوى البلح حوالي١٠٪ من الثمرة (٢). وبهذا فان كمية النوى المتخلفة من تصنيع البلح كبيرة جدا ولا يتم الاستفادة منها في معظم البلدان. ولذلك تهدف هذه الورقة البحثية عرض كيفية إنتاج الكربون المنشط من نوى البلح وكيفية تطبيقه على الاقمشة القطنية إلى جانب دراسة الخصائص المعدلة على الاقمشة القطنية بعد وضع الكربون المنشط فوقها. حيث تم تحضير الكربون المنشط على شكل مسحوق عن طريق التنشيط الكيميائي باستخدام كلوريد الزنك والحصول على CZ21. تم استخدام ثلاث أنواع مختلفة من الاقمشة القطنية وتم معالجتهم باستخدام ثلاث تركيزات مختلفة من مسحوق الكربون المنشط الذي تم تحضيره تحت الدراسة. تم تقيم فعالية خاصية مقاومة الميكروبات من خلال طريقة انتشار القرص ضد الكائنات الدقيقة. (Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans, Aspergillus niger). حيث أظهر الاقمشة القطنية المعالجة بالكربون المنشط المنتج من نوى البلح المصري الخصائص الوظيفية الجيدة.

الكلمات الدالة :

الكربون المنشط -نوى البلح -الأقمشة القطنية -خاصية مقاومة للميكروبات