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Standards Affecting Increasing the Resistance of Laboratory Clothing Fabrics to Chemicals

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Abstract: This study focuses on identifying the criteria that affect the harm and danger laboratory workers and students face from chemical reactions and combustion resulting from mixing chemicals. The study investigates the impact of fabric type, weave structure, and weft density on the resistance of laboratory clothing fabrics to chemicals. Laboratory tests were conducted to produce textile products that meet resistance specifications. The study found that the processing method used had a significant effect on improving the properties of ignition resistance and resistance to fluid permeability within the fabrics. The study used an experimental descriptive approach and statistical analysis with the SPSS program to process the data.

Keywords: Chemicals **-** Laboratory clothing, Chemical reactions

1 Introduction

In view of the rapid scientific developments and the accumulation of scientific knowledge in various fields of life, a few countries, including the Kingdom of Saudi Arabia, have been forced to strive to keep pace with this continuous development, with their ability to encourage the manufacture of technical fabrics [1-7]. Since technical fabrics play an active and vital role in all areas of life, such as Economic, social, medical and other fields. many studies have directed to this type of fabric. Where the study [1] confirmed the effect of V treatment on the physical and mechanical properties of cotton fabrics.

Another study [6] also aimed to use the technology of production and use of smart cloths data for added value in ready-made garment factories, where the study used new types of antimicrobial treatments using processing materials that combat unpleasant odors.

Despite of the interest in smart clothes and technical fabrics, there are very few studies of them toking about protect from chemical hazards, so the idea of this study came to determine the appropriate standards for protection to reduce distortions that represent a great danger for workers in Research laboratory, and for students in practical colleges while they conduct various chemical tests [5].

It is worth noting that occupational safety and health are among the necessities of work institutions for a sound work environment on the one hand, and the protection of workers from all dangers that affect their health and life during the exercise of their work. On the other hand, Offering a safe environment for students and workers practicing their activities within the institutions, for protection their health and safety [8].

2 Research problems

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Determining the most appropriate standards for both the type of raw material and the weave structural composition and processing processes to comply with the specifications of protection from hazard chemicals to which workers in laboratories are exposed.

Therefore, the problem of the study lies in answering the following questions:

1- What is the effect of the material type of material on the chemical resistance of fabrics?

2- What is the effect of weave structure on the chemical resistance of fabrics?

3- What is the effect of the density of the number of wefts on the chemical resistance of fabrics?

4- The effect of functional final processing (Fabric processing)

on the resistance of fabrics to chemicals?

3 Objectives of the Study

1- Highlighting the role of technical fabrics in health and occupational safety

2- Determine the standards affecting the fabrics used to avoid chemical risks

3- Determine the effect of different materials, structural composition, weft density and fabric processing on the properties of fabrics resistant to chemicals (ignition resistance- Burns from chemicals).

4 The importance of studying

1- Highlighting the role of protective fabrics in preserving human health and safety.

2- Highlighting the role of smart fabric production in health and occupational safety.

3- Shedding light on the importance of scientific research in the field of medical and protective fabrics.

5 Research hypotheses:

1- There are statistically significant differences between weave structure and evaluating the resistance of fabrics to chemicals

2- There are statistically significant differences between type of weft and evaluating the resistance of fabrics to chemicals

3- There are statistically significant differences between weft density and evaluating the resistance of fabrics to chemicals

4- The possibility of using a group of environmentally safe final processing materials to increase protection from the impact of exposure to chemical hazards

6 Research limits

The research is limited to the following limits

1- Objective limits: These were knowledge and skill limits.

Knowledge limits: (Enriching the role of technical fabrics in chemical resistance)

Skill limits:

Laboratory clothing fabrics of different materials (cotton - polyester - flax fibers)

- And weave structure (plain - Twill - Satin).

- Final processing with water-repellent and flammable materials such as (fluorine carbon - ammonium phosphate mixed with nitrogen - ammonium hydrogen borax).

2- Spatial limits: The research experiment is conducted in the laboratories of the Department of Home Economics, College of Education - Najran University.

3-Time limits: The practical part of the study takes 10 weeks and is theoretical according to the time plan of the supported research.

7 Research tools

To achieve the objectives of the study, the two researchers will use a number of chemically processed composite fabrics Research Methodology:

The current research uses two approaches, a descriptive approach related to defining the theoretical skills and knowledge associated with technical fabrics, an experimental approach regarding the research experiment and evaluating the effect of chemicals on laboratory clothing fabrics.

8 Research terms

Chemicals: (2) defined them as the chemical elements and their compound as they appear in their natural state, or as obtained from any production process that may contain any additive necessary to maintain the stability of the product and any impurities resulting from this process.

Laboratory clothing: A white coat or lab coat is a knee-length overcoat worn by medical professionals or by those involved in laboratory work. The coat protects the clothes at work and also the lab coat to give an appearance Professional and protective clothing (10)

9 Theoretical Frameworks

Chemical protection clothing

Protection from chemical damage means the extent to which the textile is resistant to the penetration of chemicals through it at different concentration of those materials and the duration of exposure to them (11).

Chemicals may vary according to their concentration and severity.

The research focused on laboratory clothing, whether it was the platy used in study laboratories (school, university) or used in analysis and examination laboratories.

Protective clothing is divided into two types:

- Insulating protective clothing

- Filter protective clothing

It can be divided according to usage:

- Reusable clothes (subject of research)

- Single-use clothes. (4).

10 Combustion resistances

The ignition-resistance theory lies in controlling the stages of the ignition process (initial heating - cracking or decomposing cellulose - ignition - increasing ignition).

The combustion resistance is summarized as follows:

- Covering theory
- Gaseous theory
- Thermal theory
- Hydrogen bond theory
- Chemical theory
- The theory of catalysts for the removal of two water molecules from cellulose

The method used in this research is based on the reaction with cellulose to form an oxygen-repelling compound that prevents the ignition process [3]. It is defined as the ability of fabrics to resist the penetration of liquids into fabrics at different levels of concentration and throughout the period of human exposure to them in normal, static conditions, that is, without the presence of any external force that pressures the liquid. The density of the Yarns affects the process of water absorption and permeability of the fabrics, as by increasing it, the air spaces (porosity of the fabrics) decrease, and thus the permeability of fluids decreases [7].

11. Laboratory experiments

Fabric samples under study were selected with different specifications in terms of (type of material - Weave structure - number of wefts of poison). A composite was prepared consisting of a number of organic and inorganic materials in order to perform final processing of the research samples and measure the extent of the impact of this composite on them [8-12].

First: the specifications of the samples

1- Use a warp for all samples, 100% cotton, number 40/2En, The number of yarn26/cm

2- The weft number is 24 cotton and its equivalent was used for all raw materials in different sizes (20 / cm - 30 / cm).

3- A total of 18 samples were produced, as shown in the table.

Table (1): Specification under research.

sample number	type of weft material	weave Structure	No. of wefts/cm
Sample 1	cotton	Plain weave1/1	20/ cm
Sample 2			30/ cm
Sample 3		Twill Weaves2/3	20/ cm
Sample 4			30/ cm
Sample 5		Satin weave)5	20/ cm

Sample 6			30/ cm
Sample 7	Linen	ساده Plain weave1/1	20/ cm
Sample 8			30/ cm
Sample 9		Twill Weaves2/3	20/ cm
Sample 10			30/ cm
Sample 11		Satin weave)5	20/ cm
Sample 12			30/ cm
Sample 13	Polyester	Plain weave1/1	20/ cm
Sample 14			30/ cm
Sample 15		Twill Weaves2/3	20/ cm
Sample 16			30/ cm
Sample 17		Satin weave)5	20/ cm
Sample 18			30/ cm

Secondly: Materials for the final processing of fabrics

Composite is used consisting of several materials, each of which has a role, whether to resist ignition or to resist the permeability of chemical liquids, as shown in Table 2

- The treatment material is ammonium phosphate

Where a compound of the following materials was used in different concentrations

- Fluorine carbon

And when adding borax and sodium polysilicate, it leads to a decrease in the increasing temperature and prevents the access of oxygen inside the fabrics, thus stopping the combustion process and its spread.

Table (2): Materials for preparing samples under study.

The role of the compound in the processing process	the processing material
A fluorescent organic compound based on the phenomenon of surface tension and preventing chemicals from penetrating into the fabric and enhancing its resistance to abrasion It also has stability on fabrics with washing and dry cleaning	fluorine carbon
Ammonium phosphate combines with cellulose, and it decomposes and ammonia gas escalates, which works to expel oxygen gas and thus prevents the ignition process	Ammonium phosphate (at a concentration of 150 g / liter NH2 HPO4 mixed with nitrogen
An inorganic finishing material to impart fire resistance to fabrics	Borax (Sodium Triborate
It removes water	ammonium hydrogen phosphate

Thirdly: Chemical treatment for the final processing of research samples:

The first step treatment for ignition resistance

The fabrics are immersed in a water bath containing ammonium phosphate mixed with nitrogen mixed with environmentally safe and flame-retardant materials at a concentration of 150 g / liter, and dried at 110 ° C for 15 minutes.

The second step treatment against the permeability of liquids (chemicals).

-1-Composite preparation

Fluorocarbon concentration 50%, borax concentration 20%, and ammonium hydrogen phosphate concentration 25% are added to the water bath and stirred with a mechanical stirrer for a quarter of an hour.

2-The samples treated against ignition are immersed in the first step into the prepared composite and dried at a temperature of 80 ° for 5 minutes and left for 24 hours (left in room temperature)

before conducting the tests

Fourth: Laboratory tests

1-Ignition resistance test

The samples were tested in the laboratories of the Institute of Measurement and Calibration in a standard(The sample is 15 x 10 cm) atmosphere (relative humidity 65% ± 2, temperature 20 ° C ± 2), and the ignition resistance is calculated on the basis of the area of the burnt part in centimeters, according to the standard specifications.

33 – 1957 Adapted 1996

Fluid permeability resistance test

The test was carried out according to the standard22. 1961- Adapted 1993 atmosphere (relative humidity 65% ± 2, temperature 20 ° C ± 2)

Fifth, test results (The burning time is 5 seconds)

Table (3): The ignition resistance of the samples under study.

sample number	type of weft fabric	Weave Structure	No. of wefts/cm	ignition resistance
Sample 1	cotton	Plain weave 1/1	20/ cm	It ignites immediately and turns off after 2 attempts
Sample 2			30/ cm	It turns on slowly and turns off after 2 attempts
Sample 3		Twill Weaves 2/3	20/ cm	It ignites quickly and turns off after one attempt
Sample 4			30/ cm	It ignites quickly and turns off after one attempt
Sample 5		Satin weave) 5	20/ cm	It ignites slowly and turns off after one try
Sample 6			30/ cm	It ignites slowly and turns off quickly
Sample 7	**Linen**	ساده Plain weave1/1	20/ cm	Ignites quickly and turns off after 2 attempts
Sample 8			30/ cm	It ignites quickly and turns off after one attempt
Sample 9		Twill Weaves 2/3	20/ cm	It ignites quickly and turns off after one attempt

Sample 10			30/ cm	It lights up slowly and turns off quickly
Sample 11		Satin weave) 5	20/ cm	It ignites quickly and turns off quickly
Sample 12			30/ cm	he ignition is delayed and quickly extinguished
Sample 13	Polyester	ساده Plain weave1/1	20/ cm	it ignites quickly and turns off after 3 attempts
Sample 14			30/ cm	It ignites slowly and turns off after 3 attempts
Sample 15		Twill Weaves 2/3	20/ cm	It ignites slowly and turns off after 3 attempts
Sample 16			30/ cm	It ignites slowly and turns off after 2 attempts
Sample 17		Satin weave) 5	20/ cm	It Ignites quickly and turns off after 2 attempts
Sample18			30/ cm	It ignites quickly and turns off after one attempt

Converting ignition conditions into numerical values

Table (4): Numeric values for ignition cases.

extinguishing attempts / condition ignition	3condition Ignition	Two Attempts	One Attempt	Turns off qickly
It ignites quickly	**1**	**4**	**7**	**10**
It ignites slowly	**2**	**5**	**8**	**11**
Ignition is delayed	**3**	**6**	**9**	**12**

Numeric values for ignition results and water permeability resistance 'liquid''

Table (5): For ignition results and water permeability resistance 'liquid''.

sample number	type of weft fabric	Fabric Structure	No. of wefts/cm	ignition resistance	Water permeability (liquids)
Sample 1	**cotton**	**Plain weave 1/1**	**20/ cm**	**4**	**40%**
Sample 2			**30/ cm**	**5**	**50%**
Sample 3		**Twill Weaves2/3**	**20/ cm**	**7**	**65%**
Sample 4			**30/ cm**	**7**	**70%**
Sample 5			**20/ cm**	**8**	**85%**

Sample 6		**Satin weave)5**	**30/ cm**	**11**	**96%**
Sample 7	**Linen**	**Plain weave 1/1**	**20/ cm**	**4**	**60%**
Sample 8			**30/ cm**	**7**	**75%**
Sample 9		**Twill Weaves2/3**	**20/ cm**	**7**	**70%**
Sample 10			**30/ cm**	**11**	**95%**
Sample 11		**Satin weave)5**	**20/ cm**	**10**	**92%**
Sample 12			**30/ cm**	**12**	**100%**
Sample 13	**Polyester**	**Plain weave 1/1**	**20/ cm**	**1**	**45%**
Sample 14			**30/ cm**	**2**	**50%**
Sample 15		**Twill Weaves2/3**	**20/ cm**	**2**	**50%**
Sample 16			**30/ cm**	**5**	**65%**
Sample 17		**Satin weave)5**	**20/ cm**	**4**	**70%**
Sample18			**30/ cm**	**7**	**85%**

Results of statistical hypothesis tests for research

- Results of the first statistical hypothesis test:

The first hypothesis states that "there are statistically significant differences at the level (0.05) between the mean scores for evaluating the resistance of fabrics to chemicals due to the type of weft material."

To verify the validity of this hypothesis, the researcher used the "one-way analysis of variance" test and the "LSD" test for multiple comparisons, and the results were as follows:

Table (6): The results of the one-way analysis of variance test to indicate the differences between the mean scores for evaluating the resistance of fabrics to chemicals according to the type of weft.

Property	Source of contrast	Sum of Squares	Degrees of freedom	Mean of squares	Value (p)	significance level
Ignition resistance	**Between groups**	79.00	2	39.50	**5.87**	**0.013**
	Inside groups	101.00	15	6.73		
	Total	180.00	17			
Water permeability resistance	**Between groups**	1400.33	2	700.17	**2.27**	**0.138**
	Inside groups	4634.17	15	308.94		
	Total	6034.50	17			

Table (6) shows the results of the one-way analysis of variance test to indicate the differences between the mean scores for evaluating the resistance of fabrics to chemicals according to the type of weft material, which came as follows:

1- Statistical results of the ignition resistance property:

It was found from Table (6) that there are statistically significant differences between the mean scores for evaluating the ignition resistance property according to the type of Weft material, where the value of "F" was (5.87) and the level of significance was (0.013).

Table (7): Shows the averages and standard deviations of the flame retardant property according to the type of weft.

Property	Type of weft material	N	Average	**standard deviation**
Ignition resistance	**Cotton**	**6**	**7.00**	**2.45**
	Linen	**6**	**8.50**	**3.02**
	Polyester	**6**	**3.50**	**2.26**

It can be seen from Table (7) that the average scores for evaluating the flame retardant property of cotton material were (7.0), linen material (8.50), and polyester material (3.50). In Table (8):

Table (8): LSD test results for flammability according to the type of weft.

Type of weft material (I – J)	**cotton**	**linen**	**Polyester**
Cotton	-	-1.50	3.50*
Linen	-	-	5.00*
Polyester	-	-	-

*denotes a level of 0.05

It can be seen from Table (8) that there are statistically significant differences between the average scores for evaluating the ignition resistance property between cotton and polyester in favor of cotton. While there are no statistically significant differences between cotton and linen in ignition resistance.

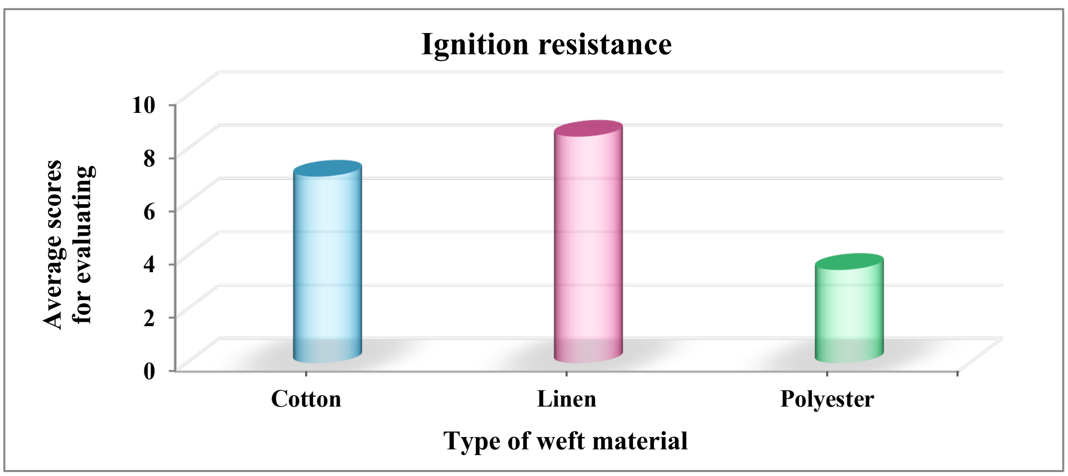

Fig. 1: Average scores for evaluating the flame retardant property according to the type of weft material.

2- Statistical results of water permeability resistance

Table (6) shows that there is no statistical evidence for the average scores for evaluating the water permeability resistance according to the type of weft material, as the value of "F" was (2.27) and the level of significance was (0.138). Table (5) shows the averages and standard deviations for the water permeability resistance property. According to the type of raw weft.

Table (9): shows the averages and standard deviations of the property of water permeability according to the type of weft.

Property	Type of weft material	n	Average	Standard deviation
Water permeability resistance	**cotton**	**6**	**67.67%**	**20.94%**
	linen	**6**	**82.00%**	**15.94%**
	Polyester	**6**	**60.83%**	**15.30%**

Table (9) shows that the average evaluation scores of the water permeability characteristic of cotton material was (67.67%), linen material (82%), and polyester material (60.83%). Figure (2) shows this.

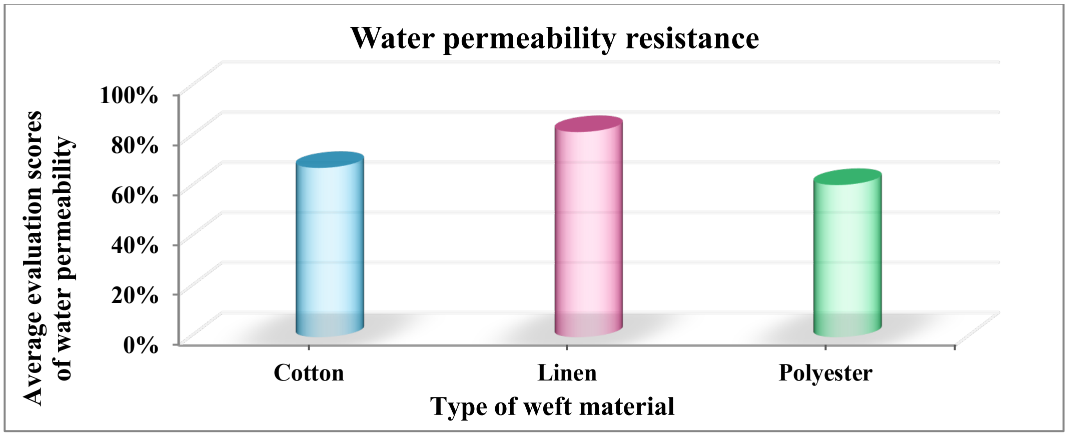

Fig.2: Average evaluation scores of water permeability according to the type of weft material. From tables (6) to (9) and their results and graphs (1) and (2), it is clear that the first statistical hypothesis was partially fulfilled.

Results of the second statistical hypothesis test:

The second hypothesis states that "there are statistically significant differences at the level (0.05) between the mean scores for evaluating the resistance of fabrics to chemicals due to the textile structure."

To verify the validity of this hypothesis, the researcher used the "ANOVA one-way analysis of variance" test and the "LSD" test for multiple comparisons, and the results were as follows:

Table (10): The results of the one-way analysis of variance test to indicate the differences between the mean scores for evaluating the resistance of fabrics to chemicals according to the textile structure.

Property	Source of contrast	Sum of Squares	Degrees of freedom	Mean of squares	Mean of squares	Level of significance
Ignition resistance	Between groups	70.33	2	35.17	4.81	**0.024**
	Inside groups	109.67	15	7.31		
	Total	180.00	17			
Water permeability resistance	Between groups	3614.33	2	1807.17	11.20	**0.001**
	Inside groups	2420.17	15	161.34		
	Total	6034.50	17			

Table (10) shows the results of the one-way analysis of variance test to indicate the differences between the mean scores for evaluating the resistance of fabrics to chemicals according to the textile structure, which came as follows:

1- Statistical results of the ignition resistance property:

Table (10) shows that there are statistically significant differences between the average scores for evaluating the flame-retardant property according to the histological structure, where the value of "F" was (4.81) and the level of significance was (0.024). .

Table (11) shows the averages and standard deviations of the flame retardant property according to the type of weft.

Property	weave Structure	n	Average	Standard deviation
Ignition resistance	Plain 1/1	6	3.83	2.14
	Twill 2/3	6	6.50	2.95
	Satin 5	6	8.67	2.94

It can be seen from Table (11) that the average scores for evaluating the flame retardant property for plain weave composition 1/1 amounted to (3.83), for weave composition Twill 3/2 (6.50), and for weave Satin 5 (8.67). The researcher tested the LSD for multiple comparisons, which came as shown in Table (12):

Table (12): Results of the LSD flame retardancy test according to the histological structure.

Textile structure I – J	Plain 1/1	Twill 2/3	Satin 5
Plain 1/1	-	-2.67	-4.83*
Twill 2/3	-	-	-2.17
Satin 5	-	-	-

* denotes a level of 0.05

It can be seen from Table (12) that there are statistically significant differences between the average scores for evaluating the flame-retardant property between the plain 1/1 weave and the Satin 5 weave in favor of Satin 5, while there are no statistically significant differences between the plain 1/1 weave and the Twill 2/3 as well as there were no statistically significant differences between the histological structure of Twill 3/2 and the Textile structure of Satin 5

Figure (3) illustrates that:

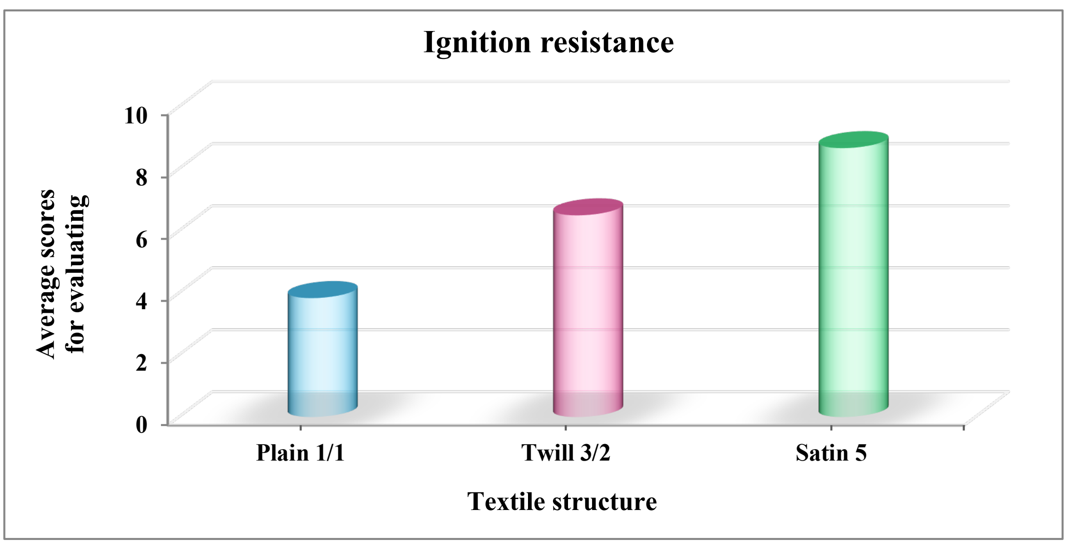

Fig.3: Average scores for Ignition resistance retardant property according to the Textile structure.

2-Statistical results of water permeability resistance:

Table (10) shows that there are statistically significant differences between the average scores for evaluating the water permeability resistance property according to the textile structure, where the value of "F" was (11.20) and the significance level was (0.001). Table (10) shows the averages and standard deviations for the water permeability resistance property according to **weave structure**

Table (13): shows the averages and standard deviations of the water permeability property according to the textile structure.

Property	weave Structure	n	Average	Standard deviation
Water permeability resistance	Plain 1/1	6	%53.33	%12.52
	Twill 2/3	6	%69.17	%14.63
	Satin 5	6	%88.00	%10.64

appears from Table (13) that the average scores for evaluating the water permeability resistance property of the plain weave composition 1/1 amounted to (53.33%), for the weave composition **Twill** 2/3 (69.17%), and for the weave composition Atlas 5 (88%), and to determine the differences between the compositions Histological and its trend, the researcher used the LSD test for multiple comparisons, which came as shown in Table (14)

Table (14): LSD test results for water permeability according to histological structure.

Textile structure	Plain 1/1	Twill 2/3	Satin 5
Plain 1/1	-	*%15.83-	*%34.67-
Twill 2/3	-	-	*%18.83-
Satin 5	-	-	-

It can be seen from Table (14) that there are statistically significant differences between the average scores for evaluating the water permeability property between the fabric structure Satin 5 and each of the plain fabric 1/1 and the fabric structure Twill 2/3 in favor of Satin 5, and there are also statistically significant differences between the fabric structure Twill 2/3 and the histology is plain 1/1 in favor of Twill 2/3.

Figure (4) illustrates that:

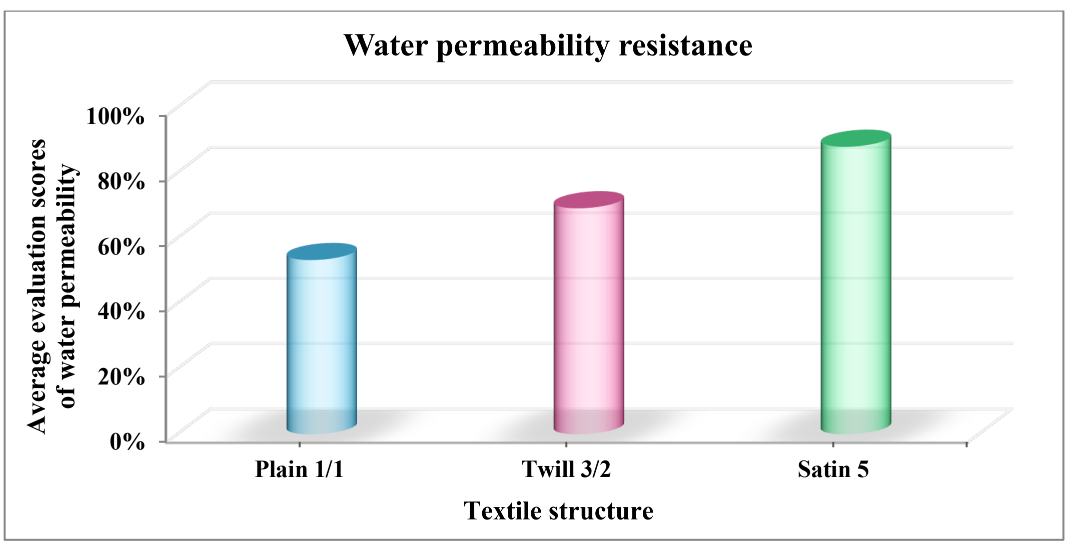

Fig.4: Average evaluation scores of water permeability property according to the type of weft material.

From tables (10) to (14) and their results and graphs (8) and (9), it is clear that the second statistical hypothesis has been fully achieved

The results of the third statistical hypothesis test:

The third hypothesis states that "there are statistically significant differences at the level of (0.05) between the average scores of the evaluation of the resistance of fabrics to chemicals due to the number of wefts.

"To verify the validity of this hypothesis, the researcher used the "T" test for independent samples, and the results were as follows:

Table (15): The results of the "T" test to indicate the differences between the averages of the evaluation scores of fabrics to chemicals according to the number of wefts.

Property	No. of wefts/cm	N	Average	Standard deviation	Value (v)	Degrees of freedom	Level of significance
Ignition resistance	20/cm	9	5.22	2.95	1.50	16	0.153
	30/cm	9	7.44	3.32			
Water permeability resistance	20/cm	9	64.11%	17.49%	1.40	16	0.180
	30/cm	9	76.22%	19.13%			

Table (15) shows the results of the "T" test to indicate the differences between the average degrees of evaluation of the resistance of fabrics to chemicals according to the number of wefts, which came as follows:

- Statistical results of the ignition resistance property

Table (15) showed that there were no statistically significant differences between the average degrees of evaluation of the ignition resistance property according to the number of wefts, where the value of "F" was (1.50) and the level of significance (0.153), and the average degrees of evaluation of the ignition resistance property for the number of wefts was 20/cm (5.22), and for the number of wefts 30/cm (7.44).

Figure (5) illustrates that.

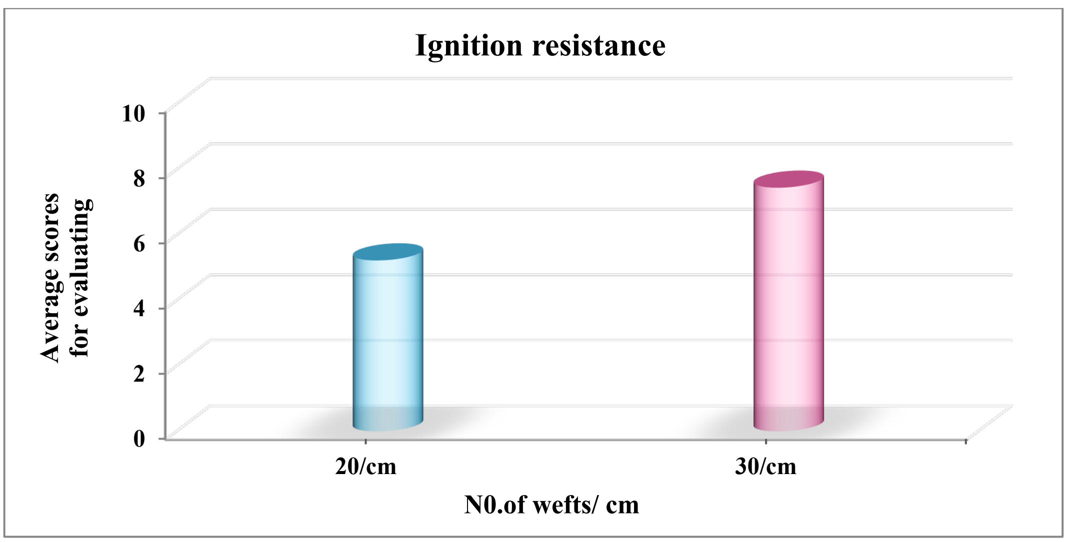

Fig.5: Average grades of evaluation of the ignition resistance property according to the number of wefts.

2- The statistical results of the water permeability resistance property

showed from Table (15) that there were no statistically significant differences between the average evaluation scores of the water permeability resistance property according to the number of wefts, where the value of "F" was (1.40) and the level of significance (0.180), and the average evaluation scores of the water permeability property for the number of wefts was 20/cm (64.11%), and for the number of wefts 30/cm (76.22%).

Figure (6) illustrates this.

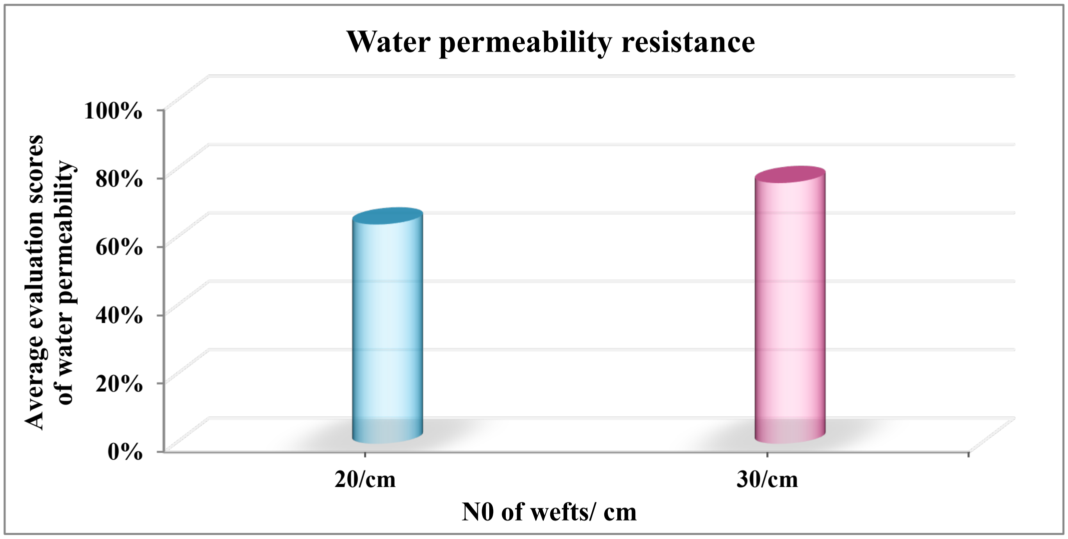

Fig.6: Average evaluation scores of water permeability according to the number of weft.

Table (15) and Figures (5) and (6) show that the third hypothesis has not been fully fulfilled.

Fourth Hypothesis Test Results:

This hypothesis states that "a range of environmentally safe final processing materials can be used to increase protection from the impact of exposure to chemical hazards."

To verify the validity of this hypothesis, the researcher carried out the quality coefficients of the research samples by calculating the relative values of the characteristics of ignition resistance and water permeability, and the results were as follows:

Table (16): Relative values and quality coefficients of research samples.

Sample Number	Type of Weft material	Textile structure	No. of wefts/cm	Functional properties		Relative values		Quality coefficient	Order
				Ignition resistance	Water permeability resistance	Ignition resistance	Water permeability resistance		
SAMPLE 1	cotton	Plain 1/1	20/cm	4	40%	33.33%	40%	36.67%	15
SAMPLE2			30/cm	5	50%	41.67%	50%	45.83%	14
SAMPLE3		Twill 2/3	20/cm	7	65%	58.33%	65%	61.67%	10
SAMPLE4			30/cm	7	70%	58.33%	70%	64.17%	8
SAMPLE5		Satin 5	20/cm	8	85%	66.67%	85%	75.83%	5

SAMPLE6			30/cm	11	96%	91.67%	96%	93.83%	2
SAMPLE7	linen	Plain 1/1	20/cm	4	60%	33.33%	60%	46.67%	13
SAMPLE8			30/cm	7	75%	58.33%	75%	66.67%	7
SAMPLE9		Twill 2/3	20/cm	7	70%	58.33%	70%	64.17%	9
SAMPLE10			30/cm	11	95%	91.67%	95%	93.33%	3
SAMPLE11		Satin 5	20/cm	10	92%	83.33%	92%	87.67%	4
SAMPLE12			30/cm	12	100%	100%	100%	100%	1
SAMPLE13	Polyester	Plain 1/1	20/cm	1	45%	8.33%	45%	26.67%	18
SAMPLE14			30/cm	2	50%	16.67%	50%	33.33%	16
SAMPLE15		Twill 2/3	20/cm	2	50%	16.67%	50%	33.33%	16 bis
SAMPLE16			30/cm	5	65%	41.67%	65%	53.33%	11
SAMPLE17		Satin 5	20/cm	4	70%	33.33%	70%	51.67%	12
SAMPLE18			30/cm	7	85%	58.33%	85%	71.67%	6

Table (16) shows that sample No. (17) came in first place with a quality factor (100%), where it achieved the highest flame resistance (12) and the highest resistance to water permeability (100%), and in second place came sample No. (6) with a quality factor (93.83%), and in third place came sample No. (10) with a quality factor (93.33%), and in fourth place came sample No. (11) with a quality factor (87.67%), and in fifth place came sample No. (5) with a quality factor (75.83%), while Sample No. (13) with a quality factor of (26.67%), where it achieved the lowest flame resistance (1) and the least resistance to water permeability (45%).

Figure (7) illustrates that

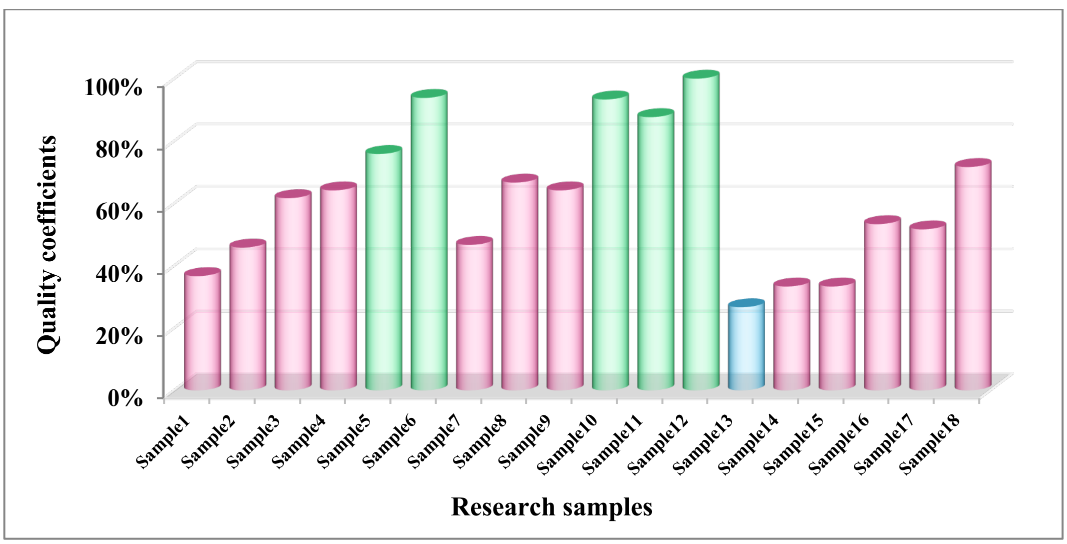

Fig.7: Quality coefficients of research samples.

Table (16) and Figure (7) show that the fourth hypothesis is fulfilled.

Conclusion:

In this paper, we found that cotton is more effective than polyester in terms of ignition resistance, while there were no significant differences between cotton and linen. Textile structure significantly affects the resistance of fabrics to chemicals, and Satin 5 is more flame-retardant than plain 1/1 weave. The study also found that the number of wefts affects the resistance of fabrics to chemicals and water permeability. The use of environmentally safe materials can increase protection from exposure to chemical hazards. The hypotheses were verified through laboratory tests and quality coefficients calculation of the research samples.

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