The Effect of Different Spinning and Finishing Methods on Cotton Fabrics Dyeing With Different Concentrations

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Abstract: The research aims at conducting the most appropriate spinning type of cotton fabrics with plain fabric construction 1/1 under variant standard conditions of microwave rays in order to improve the ability to absorb different dyes with different concentrations. The fabrics tried under research and laboratory tests were carried out at Misr Company in Al Mehalla Al- Kobra. The specifications of warp and weft yarns were 100% cotton, the picks counted 25 picks / cm, weft and warp yarn No. 20/1 were woolen Cotton and the used fabric construction was plain 1/1. Two methods of spinning were used (open –ring end spinning).Standard conditions of microwave rays are as follow: (1) Processing by microwave rays time (1,2,3) minutes. (2) Microwave energy (170,340,510,680) Watts. (3) Two types of dyes were used:(direct - active), with using two, (high of 2% - less 1%). Laboratory tests tried on the treated and dyed fabrics were made in the labs of Misr Company in Al Mahalla al-Kubra. These tests were color depth, different fastness types, (fastness against abrasion(dry – humid), fastness against wash (washing – bleeding), fastness against sweat (acidic – alkali), fastness against light. The results were statistically analyzed through using bi variance analysis system (the least significant difference) for the multi comparisons among the spun types, dye and its concentration, standard conditions of microwave rays (time- Microwave energy), tukey test (multi comparisons), quality overall assessment for research properties.The research reached the following: (1) The best sample was of ring spinning, (one minute) time, temperature 510, dye concentration + R 2%. (2) The least samples were of ring spinning, (three minutes) time, temperature 170, dye concentration + R 2%.

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1.Introduction and research problem:

Cotton is one of the best cellulosic fibers because it is distinguished by physical and mechanical characteristics, which may not exist in other fibers [1.] One of dyes that tried under research was direct dyes that dye cellulosic fibers directly without need for a mordant. This type has a low degree of wash and light fastness on cellulosic fibers, So it needs some final treatments in order to improve its fastness degree such as treating by chrom salts (to improve wash fastness) or by copper salts (to improve light fastness). Despite these treatments, fastness against light and washing is weak, but the active dyes reacts to cellulosic fibers through hydrochloric set consisting a covalent that interpret washing fastness and wet. At the same time, we find that theses dyes interact with hydrochloric set that exists in water either dyes interact with replace or adding consisting a prepared dyes that are not suitable for cellulose dyeing[2]. one of the modern approaches in dyeing process (cotton fabrics dyeing) instead of the traditional methods because it saves energy as well as reduces water consumption in addition to increase in colour depth and produce the best interaction conditions.[3]

Microwave rays are used in dyeing processes because it is distinguished by high speed and efficiency as well as saving energy. It is one of the most efficient methods for generating energy comparing to other traditional methods where energy consumption reduced to 60-70 % while treating by microwave [4], in addition, color depth and temperature have an effective role in fixing dye. [5]

So it was necessary to treat these fabrics, before dyeing, through drying by microwave rays, these rays are Electromagnetic waves that meet in space and their capacity ranges from 300 MHz to 300 GHz. These waves are situated between radio waves and infrared and they have a great wavelength (greater than 1500 watts). [6]

The photons energy emanating from microwave rays are very few so that microwave rays does not affect directly the molecular construction of materials, but they affect the atoms themselves as they are used in desizing and boiling processes in bleaching and alkali. [7]

The impact of using microwave rays on fabrics properties:

Previous studies have explained the importance of using microwave rays on fabrics properties as it resulted in increasing the tensile strength of cotton fabrics as well as increasing and used time of exposure

to microwave rays compared to the tensile strength of cotton fabrics that are not treated by microwave.

Crimping angle of cellulosic fabrics that treated by microwave rays decreased comparing to untreated fabrics.

The ability for tearing of fabrics processed by using microwave rays increased and the temperature as well as the used time. So in the field of cellulosic fabrics dyeing, microwave rays has a very important role as it can penetrate molecules of cellulosic fibers and affect the chemical and outer construction of cellulose including the improvement of some physical properties. (8)

Using microwave rays with a certain wavelength on cotton fabrics increase the fabrics resistance for crease and wrinkling. (9)

Using microwave mechanism in fabrics dyeing process resulted in:

- Reducing the time spent in dyeing processes comparing to other conventional methods for dyeing.
- Significant penetration of the dye in fabrics, resulting in high color fastness.(10)

Advantages of using microwave rays in finishing fabrics:

- The most efficient way to generate energy comparing to traditional methods as energy consumption reduces from 60-70% at processing by microwave and as a result maintaining Microwave energy. (11)
- High speed and regular distribution of heat.
- Save time and effort, increase the speed of dyeing process, and help in the dye penetration and high color fastness. (12) The study used two times of microwave (1-2 minutes), while the present research uses 3 times (1-2-3) minute. It also used three energies for microwave, while the research uses four energies (170,340,510,680) watts.

Therefore the problem of research can be shown in the following questions:

• Is there a relationship between the spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 and the two types of dye (direct – active)?

• Is there a relationship between the spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 and dye concentration (high 2% - lower 1%)?

• Is there a relationship between the spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 and dye type and concentration on microwave processing time(1,2,3) minutes.

• Is there a relationship between the spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 and dye type and concentration on microwave energy (170, 340,510, 680)watts and the impact of this on properties of functional performance.

• Is there a relationship between the spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 and dye type and concentration on microwave processing time(1,2,3) minutes, microwave energy (170, 340,510, 680) Watts for the color depth tests and different types of fastness (fastness against abrasion (dry, humid)- fastness against washing (wash – bleed) and fastness against sweat (acidic- alkali) – fastness against light.

The research importance:

The importance of research can be found in determining the best type of cotton fabrics spinning (1 | 1 using the two types of dye (direct - active) at (high 2% - less than 1%) concentration under different standard conditions of microwave rays represented in processing time (1,2,3) minutes, and microwave energy (170, 340,510, 680) Watts and the impact of this on the properties of functional performance.

Research Objectives:

T**he research aims at finding the most appropriate of the following:**

• The spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 of the two types of dye (direct – active), and its concentration (high 2% - less than 1%) on microwave time processing (1,2,3) minutes.

• The spinning type of cotton fabrics (open end and ring- end) of fabric construction plain 1 | 1 of the two types of dye (direct – active), and its concentration (high 2% - less than 1%) on microwave energy (680 510 340, 170) Watts.

Research hypotheses:

• There are significant statistically differences between spinning type of cotton fabrics (open end and ring-end) of fabric construction plain 1 | 1 and the two types of dye (direct – active).

• There are significant statistically differences between spinning type of cotton fabrics (open end and ring-end) of fabric construction plain 1 | 1 and dye concentration (high 2% - less than 1%).

• There are significant statistically differences between spinning type of cotton fabrics (open end and ring-end) of fabric construction plain 1 | 1 and types of dye, and its concentration (high 2% - less than 1%) on microwave time processing (1,2,3) minutes.

• There are significant statistically differences between spinning type of cotton fabrics (open end and ring-end) of fabric construction plain 1 | 1 and types of dye, and its concentration on microwave temperature (170, 340,510, 680) Watts.

• There are significant statistically differences between spinning type of cotton fabrics (open end and ring-end) of fabric construction plain 1 | 1 and types of dye, and its concentration on microwave processing

time(1,2,3) minutes, microwave energy (170, 340,510, 680) Watts for the color depth tests and different types of fastness (fastness against abrasion (dry, humid)- fastness against washing (wash – bleed) and fastness against sweat (acidic- alkali) – fastness against light).

Research limits:

Research variables:

• Spinning Type:(open end and ring- end).
• Dye Type: two types are used (direct -active).
• Dye concentration as two types of concentration were used: each type a higher concentration+2% and a lower concentration -1%.
• microwave time processing as (1, 2, 3) minutes are used.
• microwave energy as four types (170, 340,510, 680) Watts are used.

Research constants:

• Type of fabric construction plain 1 | 1.
• Warp and weft yarns, 100% cotton.
• Warp and weft yarns No. 20 | 1.
• The Picks number 25 picks/ cm.

Research Approach:

Research relies on the analytical experimental approach to achieve the objectives of the research.

Practical experiments and laboratory tests: -

The research aims at conducting the most appropriate spinning type of cotton fabrics with plain fabric construction 1/1 under variant standard conditions of microwave rays in order to improve the ability to absorb different dyes with two different concentrations in order to achieve the functional properties of garments fabrics.This can be done through the following:

Firstly: Implementation of fabrics samples under research:

• Fabrics with fabric construction plain 1 | 1 by using two types of spinning (open end and ring- end) were used in order to determine the most suitable one for research object at Misr Company in Al Mahalla AlKobra. Warp and weft yarns specifications were stable and they are warp cotton 100% No. 1/20 woolen cotton (English count).

Secondly, Finishing and processing and treatment of fabrics under the research -

• Bleaching process was carried out for fabrics tried under research, processing was performed by using a microwave brand LG-MS2548AR with fabric samples size 40X40 cm, and the time of microwave processing was (1,2,3) minutes, and microwave energy was (170, 340,510, 680) Watts.

Thirdly: Dyeing:

Yellow color of both direct and active dye was used as dyeing process that was tried on all samples before and after exposure to microwave rays. The dyes samples were weighed followed by dye bath that contain the dye lotion according to required amount of grey material.

Dyeing by using active dye: - by melting the dye in balanced water with these following proportions (2 g | l dye 0.8 g | l sodium carbonate 0.12 g | l sodium chloride), where the percentage of dye bath to grey material is 1:50 for dye with high concentration, as for the low concentration, It was (1 g | l dye 0.8 g | l sodium carbonate 0.12 g | l sodium chloride) and the proportion of dye bath to grey was 1:50 at a60 temperature then rinsing and saponification in order to remove the qualified dyes in hot- air oven, then drying in air.

Dyeing by using direct dye: the auxiliary materials and salts were melted in water 40 gm sodium chloride as to the dye lotion, it will be added to the bath dye before adding cotton fabric samples as they will be dyed by using gradual high bath temperature in order to finish the dye in bath quickly in fabrics at 60 temperature with continuous stirring to ensure dye harmony for 60 minutes, then rinsing in a soap lotion and using a mordant (Asmethis 10 cm^3 and a concentration 2%, 0.1%.

Practical experiments:-

Tests for color depth K/g for dyed fabrics as well as all types of fastness tests (fastness against abrasion (dry – humid), fastness against wash (washing – bleeding), fastness against sweat (acidic – alkali), fastness against light were implemented.

Color depth measurement (standard) test K/S:

In order to determine the concentration degree of dye color on fabrics and this can be assessed through assessments taken from light reflection on the dyed samples by:

Spectrophotometer Meter, Data Colour + International Model SF600

Fastness against abrasion: two types were used: (dry – humid abrasion) by:

(Crock Meter) according to the standard AATCC Test Method 8-1977

Fastness against washing: two types were used: (washing – bleeding) by:

Gray scale (1:5) in accordance with the standard. (AATCC Test Method 61-1975).

Fastness against sweat: two types were tried: (acidic-alkali) by:

Gray scale (1:5) in accordance with the standard. (AATCC Test Method 15-1973).

Fastness against light: to specify the resistance of dyed cotton grey against the daylight (sun) by: using gray scale (1:8) according to the standard (AATCC Test Method 16A-1971).

3. Results and Discussion:

First, the effect of spinning type, time, microwave energy and concentration of dye on color depth

Table (1): N - Way ANOVA Analysis of variance to specify the impact of spinning type, time, temperature and concentration of dye on color depth.

Variance source	Squares total	D.F	Squares average	"f" value	Significance level
Spinning type	2453.394	1	2453.394	1.261	.265
time	9385.369	2	4692.684	2.413	.096
microwave energy	9490.805	3	3163.602	1.626	.189
Dye concentration	1942282.760	3	647427.587	332.858	.000
Error	167274.779	86	1945.056	1.261	.265
Total	2130887.107	95			

R2 = (0.92)

The above table indicated the following:

1 – The "f" value was (1.261) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences between spinning types (open end and ring- end).

2 - The "f" value was (2.413) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences between the times levels (1.2.3) minutes.

3 - The "f" value was (1.626)and it is significant at 0.01 level, i.e, there are no statistical significant differences between microwave energy levels (170, 340 510 680).

4 - The "f" value was (332.858) and it is significant at 0.01 level, i.e, there are statistical significant difference between the levels of dye concentration (R + 2%, R-1%, D + 2%, D-1%).

Multi regression line equation came as the following:

Spinning type = X1, time= X2, temperature= X3, dye concentration= X4.

Y = 429.85 + 10.11x1 - 3.96x2 +0.026 x3-99.678x4

The researcher interpreted equation as the following:

1 – Constant (429.85) indicates that the depth of color as a value is (429.85) when spinning type = X1, time= X2, temperature= X3, dye concentration= X4 = 0.

2 - Regression coefficient (type spinning =X1) reached (10.11), a positive coefficient, indicates that the color depth increased (10.11) if spinning type increased one, assuming that spinning type = X1, time= X2, microwave energy = X3, dye concentration= X4 were constant.

3 - Regression coefficient (time =X2) reached (10.11), a positive coefficient, indicates that the color depth increased (10.11) if spinning type increased one, assuming that spinning type = X1, time= X2, microwave energy = X3, dye concentration= X4 were constant.

4 - Regression coefficient (temperature degree= X3) reached (0.026), a positive coefficient which indicates that the color depth of color increases by (0.026) whenever the microwave energy increases by one, assuming that spinning type = X1, time= X2, and dye concentration= X4 were constant.

5 - Regression coefficient (dye concentration = X3) reached (99.67), a negative coefficient which indicates that the color depth of color increases by (99.67) whenever the dye concentration increases by one, assuming that spinning type = X1, time= X2, and microwave energy = X3 were constant.

Table (2): Standard Averages and errors of spinning type, time, temperature and concentration of dye on color depth.

Variables		Average	Standard error	Rank
Spinning type	Open end	193.810	6.366	2
	Ring end	203.921	6.366	1
Time	1 minutes	209.439	7.796	1
	2 minutes	185.654	7.796	3
	3 minutes	201.502	7.796	2
Microwave energy	170	182.810	9.002	4
	340	209.163	9.002	1
	510	204.488	9.002	2
	680	199.000	9.002	3
Dye concentration	R+%2	444.553	9.002	1
	R-%1	112.103	9.002	3
	D+%2	133.716	9.002	2
	D-%1	105.090	9.002	4

To designate the difference trend among dye concentrations, the researcher applied Tukey test (multi comparisons) among these concentrations as following:

Table (3): difference among averages by using Tukey (for multi comparisons) among dye concentrations on color depth:

	112.10 aver.2% R+	112.10 aver.1% R-	133.71 aver.2%D+	105.09 aver.1% D-
444.55= averg. 2% R-		332.45*	310.83*	339.46*
112.10 aver.1% R			21.61	7.01
133.71 aver.2%D-				28.62
105.09 aver.1% D-				

Results summarized in the above table showed that there is a statistical significant difference between both:

1- **Dye concentration (2% R+) and concentration (2%D+, (1% D-) as the differences among averages of color depth reached (339.46 ،310.83 ،332.45) and it has a significant effect.**

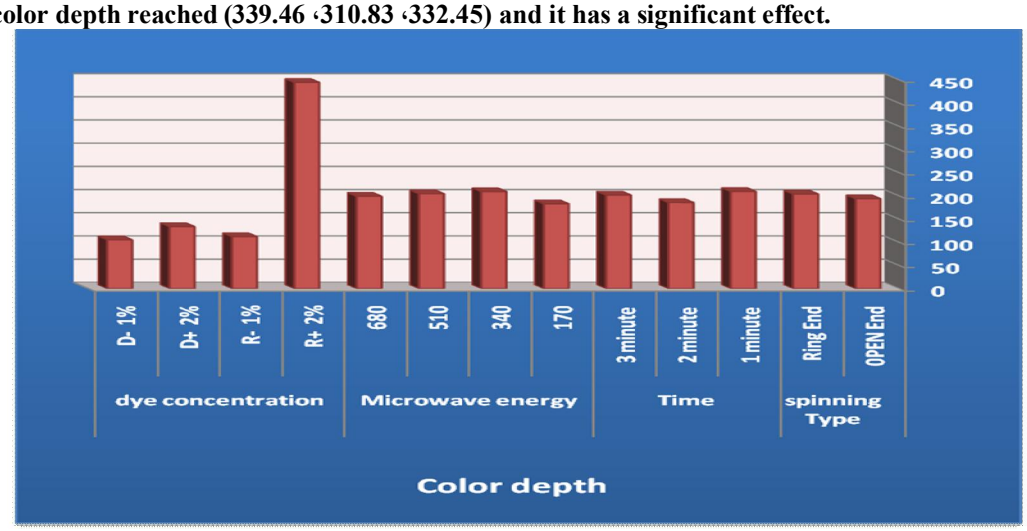

Figure 1: Effect of Spinning type, time, microwave energy and concentration of dye on color depth

Secondly: Effect of Spinning type, time, temperature and concentration of dye on fastness against abrasion (humid- dry)

Table (4): N - Way ANOVA Analysis of variance to specify the impact of spinning type, time, temperature and concentration of dye on fastness against abrasion (humid- dry)

Fastness against abrasion	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
Dry	Spinning type	1.042	1	1.042	5.520	.021
	time	.438	2	.219	1.159	.319
	temperature	.375	3	.125	.662	.577
	Dye concentration	7.542	3	2.514	13.321	.000
	Error	16.229	86	.189	5.520	.021
	Total	25.625	95			
Humid	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
	Spinning type	.094	1	.094	.273	.603
	time	.563	2	.281	.819	.444
	temperature	.448	3	.149	.435	.729
	Dye concentration	10.531	3	3.510	10.227	.000
	Error	29.521	86	.343		.603
	Total	41.156	95			

Dry R^2 = (0.36) Humid R2 = (0.28)

The above table indicated the following:

1- The "f" value was (5.520) and it is significant at 0.01 level, i.e, there are statistical significant differences between the spinning types (open end- ring end) in the property of fastness against abrasion dry, where "f" value was (0.273) and it is insignificant between the spinning types (open end- ring end) in the property of fastness against abrasion(humid).

2- The "f" value was 1.159) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences among the times levels (1,2, 3 minutes) in the property of fastness against abrasion dry, where "f" value was (0.819) and it

is insignificant among the times levels (1,2, 3 minutes) in the property of fastness against abrasion (humid).

3- The "f" value was (0.662) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences among microwave energy degree levels (170, 340, 510, 680)) in the property of fastness against abrasion dry, where "f" value was (0.435) and it is insignificant among microwave energy degree levels (170, 340, 510, 680) the times levels (1,2, 3 minutes) in property of fastness against abrasion (humid).

4- The "f" value was (13.321) and it is significant at 0.01 level, i.e, there are statistical significant differences among the dye concentrations (2% R+, 1% R-, 2%D+, 1%D-) in the property of fastness against abrasion dry, where "f" value was (10.227) and it is significant among the dye concentrations (2% R+, 1% R-, 2%D+, 1%D-) in the property of fastness against abrasion (humid).

Multi regression line equation came as what follows:

Spinning type = X1, time= X2, microwave energy **= X3, dye concentration= X4.**

fastness against abrasion (dry)	**Y= 2.594 + 0.208x1 + 0.016x2+0.000x3+ 0.250x4**
Fastness against abrasion (humid)	**Y= 2.052 + 0.063x1 + 0.047x2+0.000x3+ 0.0880x4**

Table (5) Standard Averages and errors of spinning type, time, microwave energy and concentration of dye on fastness against abrasion (dry- humid).

Variables		Dry			Humid		
		Average	Standard error	Rank	Average	Standard error	Rank
Spinning type	Open end	3.458	.063	2	2.563	.085	2
	Ring end	3.667	.063	1	2.625	.085	1
Time	1 minutes	3.500	.077	3	2.500	.104	3
	2 minutes	3.656	.077	1	2.688	.104	1
	3 minutes	3.531	.077	2	2.594	.104	2
Microwave energy	170	3.500	.089	4	2.542	.120	3
	340	3.667	.089	1	2.542	.120	3
	510	3.542	.089	2	2.583	.120	2
	680	3.542	.089	3	2.708	.120	1
Dye concentration	%2 R+	3.208	.089	4	2.375	.120	2
	1%R-	3.417	.089	3	2.917	.120	1
	%2 D+	3.667	.089	2	2.167	.120	3
	%1 D-	3.958	.089	1	2.917	.120	1

To designate the difference trend among dye concentrations, the researcher applied Tukey test (multi comparisons) among these concentrations as following:

		%2 R+ Averg. 3.20	1%R-	%2 D+	1 %D-
Fastness against abrasion (dry)	%2 R+ Averg. 3.20		.20	. 45*	.75*
	1% R- Averg. 3.41			.25	.54*
	%2 D+ Averg. 3.66				.29
	1% D- Averg. 3.95				
		%2 R+ Averg. 2.37	1% R- Averg. 2.91	%2 D+ Averg. 2.16	1% D- Averg. 2.91
Fastness against abrasion(humid)	%2 R+ Averg. 2.37		.54*	.20	.54*
	1% R- Averg. 2.91			.75*	00
	%2 D+ Averg. 2.16				.75*
	1% D- Averg. 2.91				

Results summarized in the above table showed that there are statistical significant differences between both:

1- **Dye concentration (**R+%2) and (D+%2 , D-%1as the differences among averages of fastness against abrasion (dry) reached (0.45, 0.75) and it has a significant effect, as for the differences among averages of fastness against abrasion (humid) reached(0.45) of dye concentration (1% R-, 1% D-) respectively.It has a significant effect.

2- **Dye concentration (**1% R-) and (1% D-)as the differences among averages of fastness against abrasion (dry) reached (0.54) and it has a significant effect, as for the differences among averages of fastness against abrasion (humid) reached(0.75) of dye concentrations (2% D+). It has a significant effect.

3- **Dye concentration (**2% D+) and (1% D-) as the differences among averages of fastness against abrasion (humid) reached (0.75) and it has a significant effect.

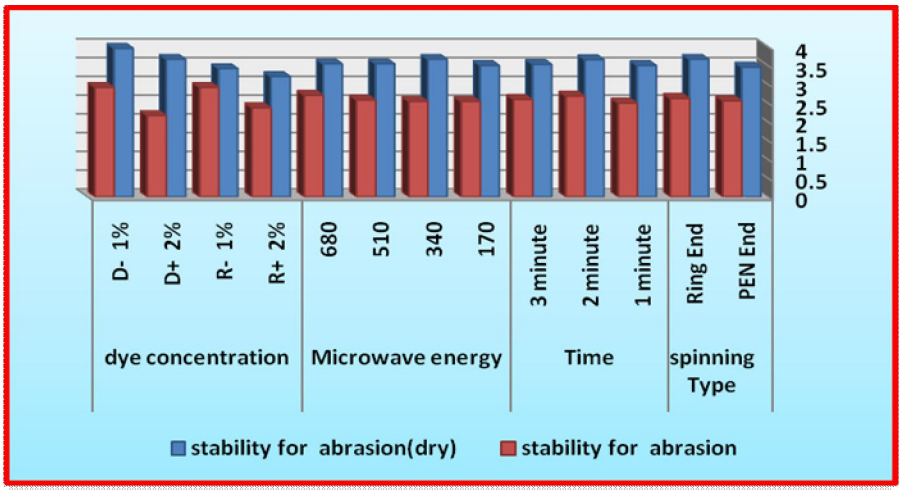

Figure 2 Effect of Spinning type, time, microwave energy and **concentration of dye on fastness against abrasion**

Thirdly: Effect of Spinning type, time, microwave energy and **concentration of dye on fastness against washing (washing- bleeding)**

Table (4) N - Way ANOVA Analysis of variance to specify the impact of spinning type, time, microwave energy and concentration of dye on fastness against washing(washing- bleeding)

Fastness against washing	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
Washing	Spinning type	.000	1	.000	.000	1.000
	time	.896	2	.448	1.349	.265
	microwave energy	.458	3	.153	.460	.711
	Dye concentration	40.042	3	13.347	40.188	.000
	Error	28.563	86	.332		
	Total	69.958	95			
Bleeding	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
	Spinning type	.844	1	.844	2.681	.105
	time	.771	2	.385	1.225	.299
	microwave energy	.865	3	.288	.916	.437
	Dye concentration	17.448	3	5.816	18.482	.000
	Error	27.063	86	.315		
	Total	46.990	95			

Bleeding R2 = (0.42) washing R2 = (0.60)

The above table indicated the following:

1- The "f" value was (2.681) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences between the spinning types (open end- ring end) in the property of fastness against washing (bleeding), where "f" value was (0.00) and it is insignificant between the spinning types (open end- ring end) in the property of fastness against washing (washing).

2- The "f" value was (0.01) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences among time levels (1,2,3 minutes) in

the property of fastness against washing (washing), where "f" value was (1.225) and it is insignificant among time levels in the property of fastness against washing (bleeding).

3- The "f" value was (0.460) and it is insignificant at 0.01 level, i.e, there is no statistical significant differences among **microwave energy** levels (170,340,510,680) in the property of fastness against washing (washing), where "f" value was (0.916) and it is insignificant among temperature levels (170,340,510,680) in the property of fastness against washing (bleeding).

4- The "f" value was (40.188) and it is significant at 0.01 level, i.e, there are statistical significant differences among dye concentration levels (2% R+, 1% R-, 2% D+, 1% D-) in the property of fastness against washing (washing), where "f" value was (18.482) and it is significant among dye concentration levels (2% R+, 1% R-, 2% D+, 1% D-)) in the property of fastness against washing (bleeding).

Multi regression line equation came as what follows:
spinning type = X1, time= X2, microwave energy = X3, dye concentration= X4.

fastness against washing (wash)	**Y= 3.531 + 0.00x1 + 0.016x2+0.000x3+ 0.383x4**
Fastness against washing (bleeding)	**Y= 2.958 + 0.188x1 - 0.063x2+0.000x3- 0.263x4**

Table (8) Standard Averages and errors of spinning type, time, microwave energy and concentration of dye on fastness against abrasion (washing- bleeding).

Variables		Washing			Bleeding		
		Average	Standard error	Rank	Average	Standard error	Rank
Spinning type	Open end	2.479	.083	1	2.229	.081	2
	Ring end	2.479	.083	1	2.417	.081	1
Time	1 minutes	2.563	.102	1	2.438	.099	1
	2 minutes	2.344	.102	3	2.219	.099	3
	3 minutes	2.531	.102	2	2.313	.099	2
Microwave energy	170	2.458	.118	2	2.375	.115	2
	340	2.542	.118	1	2.333	.115	3
	510	2.542	.118	1	2.417	.115	1
	680	2.375	.118	3	2.167	.115	4
Dye concentration	%2 R+	2.708	.118	3	2.625	.115	2
	1%R-	2.833	.118	2	2.333	.115	3
	%2 D+	2.479	.118	1	2.708	.115	1
	%1 D-	2.479	.118	4	1.625	.115	4

To designate the difference trend among dye concentrations, the researcher applied Tukey test (multi comparisons) among these concentrations as following:

Table (9) differences among by using (tukey) tests (for multi comparisons) among dye concentration levels on fastness washing (washing- bleeding).

		%2 R+ Averg. 3.20	1%R- Averg. 2.83	%2 D+ Averg. 3.00	1 %D- Averg. 1.37
Fastness against washing(washing)	%2 R+ Averg. 2.70		.12	0.29	1.33*
	1% R- Averg. 2.83			.25	1.45 *
	%2 D+ Averg. 3.00				1.62 *
	1% D- Averg. 1.37				
		%2 R+ Averg2.62	1% R- Averg. 2.33	%2 D+ Averg. 2.70	1% D- Averg. 1.62
Fastness against washing(breeding)	%2 R+ Averg. 2.62		.29	.08	1.00 *
	1% R- Averg. 2.33			.37	.70*
	%2 D+ Averg. 2.70				1.08*
	1% D- Averg. 1.62				

Results summarized in the above table showed that there are statistical significant differences between both:

1- **Dye concentration (**2% R+) and (1% D-)as the differences among averages of fastness against washing (wash) reached (1.33) and it has a significant effect, as for the differences among averages of fastness against washing (bleeding) reached(1.00) of dye concentration (1% D-). It has a significant effect.

2- **Dye concentration (**1% R-) and (1% D-)as the differences among averages of fastness against washing (wash) reached (1.45) and it has a significant effect, as for the differences among averages of fastness against washing (bleeding) reached(0.70) of dye concentration (1% D-). It has a significant effect.

3- **Dye concentration (**2% D+) and (1% D-)as the differences among averages of fastness against washing (wash) reached (1.62) and it has a significant effect, as for the differences among averages of fastness against washing (bleeding) reached(1.08) of dye concentration (1% D-). It has a significant effect.

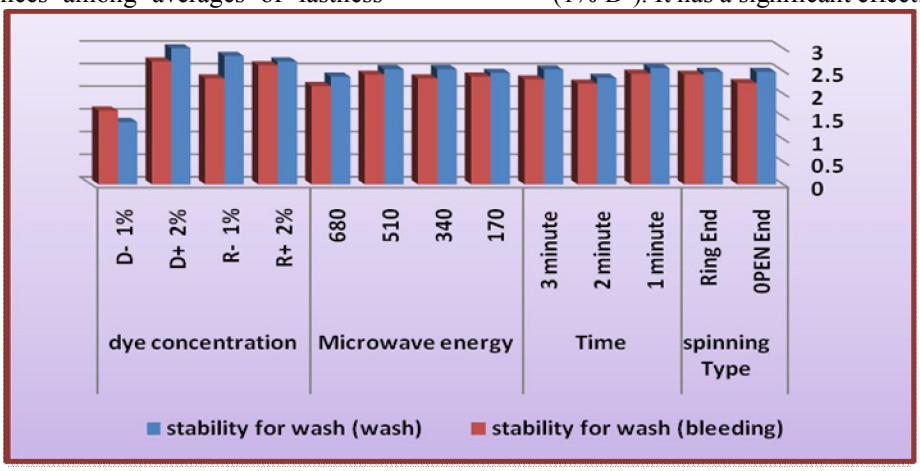

Figure 3 Effect of Spinning type, time, microwave energy and concentration of dye on fastness against washing (wash- bleeding)

Table (10) N - Way ANOVA Analysis of variance to specify the impact of spinning type, time, microwave energy and concentration of dye on fastness against sweat(acidic- alkali)

Fastness against sweat	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
Acidic	Spinning type	.010	1	.010	.016	.898
	time	.771	2	.385	.607	.547
	microwave energy	.281	3	.094	.148	.931
	Dye concentration	18.115	3	6.038	9.517	.000
	Error	54.563	86	.634		
	Total	73.740	95			
	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
Alkali	Spinning type	.510	1	.510	1.328	.252
	time	.271	2	.135	.352	.704
	microwave energy	1.781	3	.594	1.544	.209
	Dye concentration	41.865	3	13.955	36.298	.000
	Error	33.063	86	.384		
	Total	77.490	95			

Bleeding R^2 = (0.57) **washing R^2** = (0.26)

The aforementioned table explained the following:

1- The "f" value reached(0.16) and it is insignificant at 0.01 level, i.e, there is no statistical significant differences between the spinning types (open end- ring end) in the property of fastness against sweat (acidic), where "f" value was (1.328) and it is insignificant between the spinning types (open end- ring end) in the property of fastness against sweat (alkali).

2- The "f" value reached(0.607) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences between the time levels (1,2,3 minutes) in the property of fastness against sweat (acidic), where "f" value was (0.352) and it is insignificant among time levels in the property of fastness against sweat (alkali).

3- The "f" value reached(0.148) and it is insignificant at 0.01 level, i.e, there are no

statistical significant differences among the temperature levels (170,340,510,680) in the property of fastness against sweat (acidic), where "f" value was (1.544) and it is insignificant among the temperature levels (170,340,510,680) in the property of fastness against sweat (alkali).

4- The "f" value reached(9.517) and it is significant at 0.01 level, i.e, there are no statistical significant differences among dye concentrations (2% R+, 1% R-, 2% D+, 1% D-) in the property of fastness against sweat (acidic), where "f" value was (36.298) and it is significant among dye concentrations levels (2% R+, 1% R-, 2% D+, 1% D-) in the property of fastness against sweat (alkali).

Multi regression line equation came as what follows:
Spinning type = X1, time= X2, microwave energy = X3, dye concentration= X4.

fastness against sweat (acidic)	**Y= 1.948 - 0.021x1 + 0.109x2+0.000x3+ 0.271x4**
Fastness against sweat (alkali)	**Y= 1.990 + 0.146x1 + 0.047x2+0.000x3+ 0.113x4**

Table (11) Standard Averages and errors of spinning type, time, microwave energy and concentration of dye on fastness against sweat(acidic, alkali)

Variables		Acidic			Alkali		
		Average	Standard error	Rank	Average	Standard error	Rank
Spinning type	Open end	2.896	.115	1	2.354	.089	2
	Ring end	2.875	.115	2	2.500	.089	1
time	1 minutes	2.781	.141	3	2.406	.110	2
	2 minutes	2.875	.141	2	2.375	.110	3
	3 minutes	3.000	.141	1	2.500	.110	1
microwave energy	170	2.833	.163	3	2.458	.127	2
	340	2.917	.163	2	2.625	.127	1
	510	2.833	.163	3	2.250	.127	4
	680	2.958	.163	1	2.375	.127	3
Dye concentration	%2 R+	2.417	.163	4	2.000	.127	3
	1%R-	3.083	.163	2	3.208	.127	1
	%2 D+	2.542	.163	3	1.583	.127	4
	%1 D-	3.500	.163	1	2.917	.127	2

To mark out the difference trend among dye concentrations, the researcher applied Tukey test (multi comparisons) among these concentrations as following:

Table (12) differences among by using (tukey) tests (for multi comparisons) among dye concentration levels on fastness against sweat (acidic- alkali).

		%2 R+ Averg. 2.41	1%R- Averg. 3.08	%2 D+ Averg. 2.54	1 %D- Averg. 3.50
fastness against sweat(acidic)	%2 R+ Averg. 2.41		.66 *	.12-	1.08*
	1% R- Averg. 3.08			.54	.41
	%2 D+ Averg. 2.54				,95 *
	1% D- Averg. 3.50				
		%2 R+ Averg2.62	1% R- Averg. 2.33	%2 D+ Averg. 2.70	1% D- Averg. 1.62
fastness against sweat(alkali)	%2 R+ Averg. 2.00		1.20 *	.41	.91 *
	1% R- Averg. 3.20			1.62*	.29
	%2 D+ Averg. 1.58				1.33*
	1% D- Averg. 2.91				

Results summarized in the above table showed that there are statistical significant differences between both:

1- **Dye concentration (**2% R+) and (1% R-,1% D-)as the differences among averages of fastness against sweat(acidic) reached (1.08, 0.66) and it has a significant effect, regarding the differences among averages of fastness against sweat (alkali) reached(1.20, 0.99) of dye concentration (1% R-,1% D-).it has a significant effect.

2- **Dye concentration (**2% D+) and (1% D-)as the differences among averages of fastness against sweat(acidic) reached (0.95) and it has a significant effect, while the differences among averages of fastness against sweat (alkali) reached(1.33) of dye concentration (1% D-) and it has a significant effect.

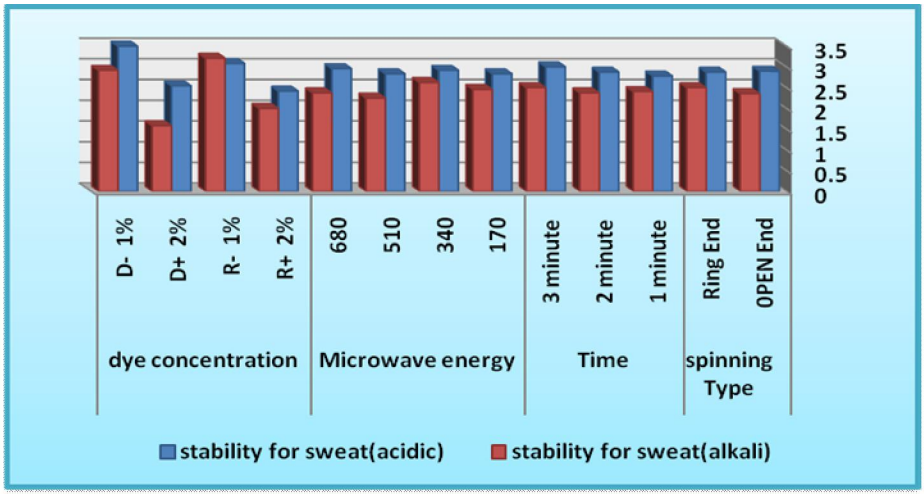

Figure 4. Effect of Spinning type, time, microwave energy and concentration of dye on fastness against sweat (acidic- alkali)

Fifth: Effect of Spinning type, time, microwave energy and concentration of dye on fastness against light.

Table (13) N - Way ANOVA Analysis of variance to specify the impact of spinning type, time, temperature and concentration of dye on fastness against light

Fastness against light	Variance source	Squares total	D.F	Squares average	"f" value	Significance level
washing	Spinning type	**1.500**	**1**	**1.500**	**2.753**	**.101**
	time	**.396**	**2**	**.198**	**.363**	**.696**
	microwave energy	**.917**	**3**	**.306**	**.561**	**.642**
	Dye concentration	**247.667**	**3**	**82.556**	**151.529**	**.000**
	Error	**46.854**	**86**	**.545**		
	Total	**297.333**	**95**			

R2 = (0.84)

The above table showed that:

1- The "f" value was (2.753) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences between the spinning types (open end- ring end).

2- The "f" value was (0.363) and it is insignificant at 0.01 level, i.e, there are no statistical significant differences among the time levels (1,2,3, minutes).

3- The "f" value was (0.561) and it is significant at 0.01 level, i.e, there is a statistical significant differences among temperature levels (170,340, 510,680).

4- The "f" value was (151.529) and it is significant at 0.01 level, i.e, there are statistical significant differences among dye concentrations(2% R+, 1% R-, 2% D+, 1% D-).

Multi regression line equation came as what follows:

spinning type = X1, time= X2, microwave energy = X3, dye concentration= X4.

fastness against light	$Y= 7.74 + 0.25x_1 + 0.078x_2-4.90x_3+ 1.33x_4$

Table (14) Standard Averages and errors of spinning type, time, microwave energy and concentration of dye on fastness against light

Variables		Average	Standard error	Rank
Spinning type	Open end	4.792	.107	2
	Ring end	5.042	.107	1
time	1 minutes	4.844	.130	3
	2 minutes	4.906	.130	2
	3 minutes	5.000	.130	1
microwave energy	170	4.958	.151	2
	340	4.958	.151	2
	510	4.750	.151	3
	680	5.000	.151	1
Dye concentration	%2 R+	6.333	.151	2
	1%R-	6.583	.151	1
	%2 D+	4.000	.151	3
	%1 D-	2.750	.151	4

In order to identify the difference trend among dye concentrations, the researcher applied Tukey test (multi comparisons) among these concentrations as following:

Table (15) differences among averages by using (tukey) tests (for multi comparisons) among dye concentration levels on fastness against light.

	%2 R+ Averg. 6.33	1%R- Averg. 6.58	%2 D+ Averg. 4.00	1 %D- Averg. 2.75
%2 R+ Averg. 6.33		.25	2.33*	3.58*
1% R- Averg. 6.58			2.58*	3.83*
%2 D+ Averg. 4.00				1.25*
1% D- Averg. 2.75				

Results summarized in the above table showed that there are statistical significant difference between both:

1- **Dye concentration** (2% R+) and (2% D+,1% D-)as the differences among averages of fastness against light reached (2.33, 3.58) and it has a significant effect.
2- **Dye concentration** (1% R-) and (2% D+, 1% D-) as the differences among averages of fastness against light were (2.58, 3.58) and it has a significant effect.
3- **Dye concentration** (2% D+) and (1% D -) as the differences among averages of fastness against light were (1.25) and it has a significant effect.

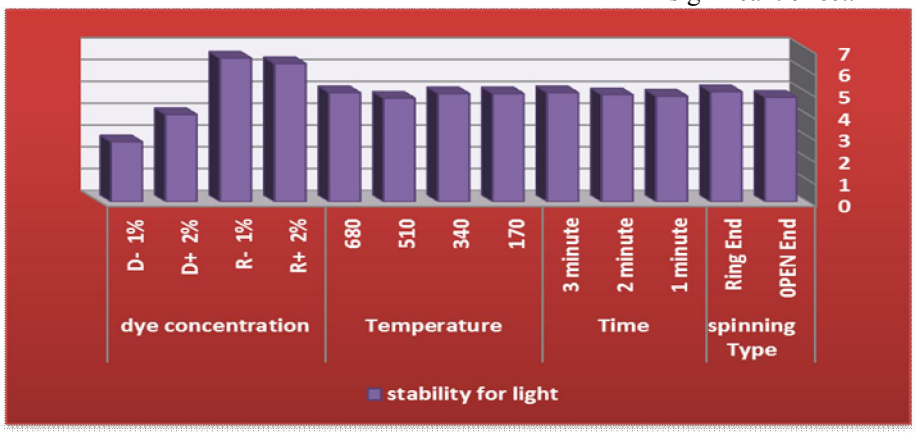

Figure (5) Effect of Spinning type, time, microwave energy and concentration of dye on fastness against light

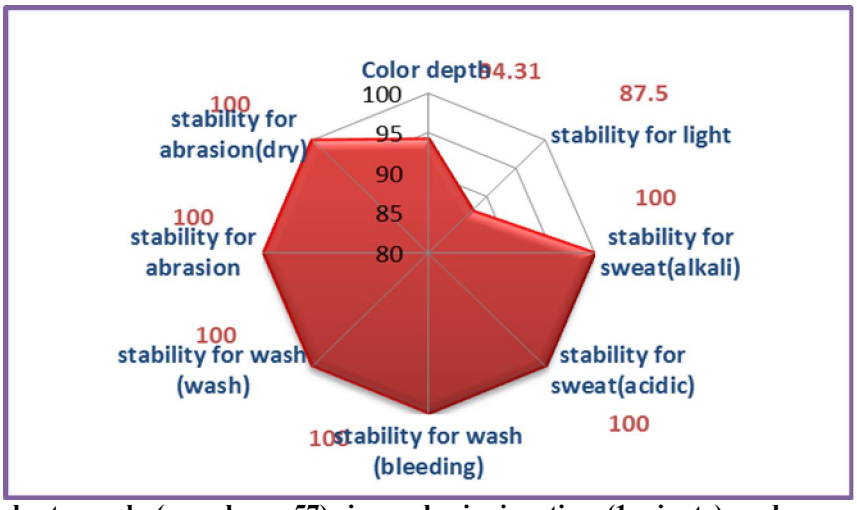

Figure (6) The best samples(sample no. 57) ring end spinning, time (1 minute), and energy 510, and dye concentration 2% R+

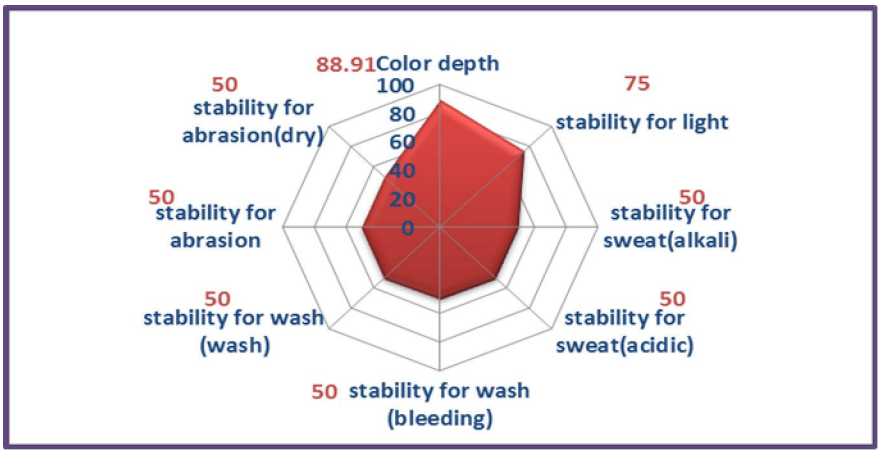

Figure (7) The best samples(sample no. 57) ring end spinning, time (1 minute), microwave energy 510, and dye concentration 2% R+

Table (13) Overall assessment of research properties

Sample No.	Spinning type	Time	microwave energy	Dye concentration	Color depth	Fastness for abrasion dry	Fastness for abrasion humid	Fastness for wash washing	Fastness for wash bleeding	Fastness for sweat acidic	Fastness for sweat alkali	Fastness for Light	Model distance
1				2% R+	65.84	75	75	75	75	75	75	75	590.84
2			170	1% R-	20.06	75	75	75	75	75	75	75	545.06
3				2% D+	23.73	75	75	75	75	75	75	50	523.73
4				1% D-	21.72	100	100	100	100	100	100	25	646.72
5				2% R+	73.90	75	75	75	75	75	75	75	598.90
6			340	1% R-	19.85	75	75	75	75	75	75	87.5	557.35
7				2% D+	22.30	75	75	75	75	75	75	50	522.30
8		1 minute		1% D-	20.09	100	100	100	100	100	100	25	645.09
9				2% R+	89.87	75	75	75	75	75	75	62.5	602.37
10			510	1% R-	21.35	75	75	75	75	75	75	75	546.35
11				2% D+	23.15	100	100	100	100	100	100	50	673.15
12				1% D-	20.01	100	100	100	100	100	100	25	645.01
13				2% R+	80.49	100	100	100	100	100	100	75	755.49
14			680	1% R-	17.97	75	75	75	75	75	75	75	542.97
15				2% D+	23.79	75	75	75	75	75	75	50	523.79
16				1% D-	16.81	100	100	100	100	100	100	25	641.81
17	Open end			2% R+	70.00	100	100	100	100	100	100	75	745.00
18			170	1% R-	17.51	75	75	75	75	75	75	87.5	555.01
19				2% D+	21.06	100	100	100	100	100	100	75	696.06
20				1% D-	19.02	100	100	100	100	100	100	25	644.02
21				2% R+	83.48	75	75	75	75	75	75	87.5	620.98

22		2 minutes	340	1% R-	19.51	75	75	75	75	75	75	75	544.51
23				2% D+	22.59	100	100	100	100	100	100	50	672.59
24				1% D-	17.48	100	100	100	100	100	100	25	642.48
25			510	2% R+	78.59	100	100	100	100	100	100	75	753.59
26				1% R-	17.65	75	75	75	75	75	75	75	542.65
27				2% D+	22.95	100	100	100	100	100	100	50	672.95
28				1% D-	17.62	100	100	100	100	100	100	25	642.62
29			680	2% R+	66.25	75	75	75	75	75	75	75	591.25
30				1% R-	18.79	75	75	75	75	75	75	75	543.79
31				2% D+	22.02	75	75	75	75	75	75	50	522.02
32				1% D-	17.42	100	100	100	100	100	100	37.5	654.92
33		3 minutes	170	2% R+	67.97	75	75	75	75	75	75	87.5	605.47
34				1% R-	20.29	75	75	75	75	75	75	87.5	557.79
35				2% D+	23.23	100	100	100	100	100	100	50	673.23
36				1% D-	19.20	75	75	75	75	75	75	25	494.20
37			340	2% R+	88.05	75	75	75	75	75	75	87.5	625.55
38				1% R-	19.94	100	100	100	100	100	100	87.5	707.44
39				2% D+	22.38	100	100	100	100	100	100	50	672.38
40				1% D-	19.76	100	100	100	100	100	100	37.5	657.26
41			510	2% R+	69.72	75	75	75	75	75	75	75	594.72
42				1% R-	30.20	75	75	75	75	75	75	87.5	567.70
43				2% D+	21.32	75	75	75	75	75	75	50	521.32
44				1% D-	18.01	100	100	100	100	100	100	25	643.01
45			680	2% R+	72.85	75	75	75	75	75	75	75	597.85
46				1% R-	19.96	75	75	75	75	75	75	75	544.96
47				2% D+	26.05	100	100	100	100	100	100	50	676.05
48				1% D-	18.68	100	100	100	100	100	100	62.5	681.18
49	Ring End	1 minute	170	2% R+	88.21	75	75	75	75	75	75	87.5	625.71
50				1% R-	19.37	100	100	100	100	100	100	87.5	706.87
51				2% D+	26.12	75	75	75	75	75	75	50	526.12
52				1% D-	18.61	100	100	100	100	100	100	62.5	681.11
53			340	2% R+	86.42	100	100	100	100	100	100	87.5	773.92
54				1% R-	21.50	100	100	100	100	100	100	87.5	709.00
55				2% D+	22.75	100	100	100	100	100	100	50	672.75
56				1% D-	18.24	100	100	100	100	100	100	25	643.24
57			510	2% R+	94.31	100	100	100	100	100	100	87.5	781.81
58				1% R-	21.27	75	75	75	75	75	75	87.5	558.77
59				2% D+	24.05	100	100	100	100	100	100	50	674.05
60				1% D-	22.08	100	100	100	100	100	100	37.5	659.58
61			680	2% R+	100.00	75	75	75	75	75	75	75	625.00
62				1% R-	19.68	75	75	75	75	75	75	87.5	557.18
63				2% D+	25.46	75	75	75	75	75	75	50	525.46
64				1% D-	20.04	100	100	100	100	100	100	25	645.04
65		2 minutes	170	2% R+	24.68	75	75	75	75	75	75	75	549.68
66				1% R-	18.32	100	100	100	100	100	100	87.5	705.82
67				2% D+	24.03	100	100	100	100	100	100	50	674.03
68				1% D-	17.84	100	100	100	100	100	100	25	642.84
69			340	2% R+	90.50	75	75	75	75	75	75	75	615.50
70				1% R-	21.65	100	100	100	100	100	100	87.5	709.15
71				2% D+	26.02	100	100	100	100	100	100	50	676.02
72				1% D-	18.05	100	100	100	100	100	100	25	643.05
73			510	2% R+	91.96	75	75	75	75	75	75	75	616.96
74				1% R-	20.70	75	75	75	75	75	75	87.5	558.20
75				2% D+	24.45	100	100	100	100	100	100	50	674.45
76				1% D-	9.87	100	100	100	100	100	100	37.5	647.37
77			680	2% R+	71.27	100	100	100	100	100	100	87.5	758.77
78				1% R-	19.21	100	100	100	100	100	100	87.5	706.71
79				2% D+	24.20	100	100	100	100	100	100	50	674.20
80				1% D-	19.32	100	100	100	100	100	100	50	669.32
81		3 minutes	170	2% R+	88.91	50	50	50	50	50	50	75	463.91
82				1% R-	17.89	100	100	100	100	100	100	87.5	705.39
83				2% D+	24.45	100	100	100	100	100	100	37.5	661.95
84				1% D-	20.34	100	100	100	100	100	100	25	645.34
85			340	2% R+	97.92	75	75	75	75	75	75	75	622.92
86				1% R-	16.58	100	100	100	100	100	100	75	691.58
87				2% D+	22.21	100	100	100	100	100	100	50	672.21
88				1% D-	19.44	100	100	100	100	100	100	62.5	681.94
89			510	2% R+	68.91	75	75	75	75	75	75	87.5	606.41
90				1% R-	17.62	100	100	100	100	100	100	75	692.62
91				2% D+	25.78	75	75	75	75	75	75	50	525.78
92				1% D-	19.26	100	100	100	100	100	100	25	644.26
93			680	2% R+	82.77	75	75	75	75	75	75	87.5	620.27
94				1% R-	20.47	100	100	100	100	100	100	75	695.47
95				2% D+	25.27	100	100	100	100	100	100	37.5	662.77
96				1% D-	18.56	100	100	100	100	100	100	62.5	681.06

Conclusion:

As the Applied studies and statistical treatments of the results of properties quality indicated and in order to achieve the general aim of the research that is represented in The effect of different spinning and finishing methods on cotton fabrics dyeing with different concentrations, we would became able to get the best five specifications of dyeing cotton fabrics with plain fabric construction 1/1 at using two types of spinning (open- end and ring –end).Table (16) and radar charts (6,7) made us conclude the following:sample no (57) ring –end (time 1 minute), energy(510, concentration +R 2% was the best samples tried under research followed by sample no (53) ring –end (time 2 minutes), energy(680), concentration +R 2%, and finally the least sample was sample no (81) ring –end (time 3 minute), energy(170, concentration +R 2%.

Recommendations of study:

In the light of previous studies and the applied experiments, we would able to abstract the most important thing that can add anew in the field of processing the spinning types of cotton fabrics with microwave rays as well as dyeing with different types and concentrations, So the study recommends the following:

1- Reset another standard specifications for dyeing cotton fabrics that conform with modern developments in the field of fabrics processing technology.
2- It is very important to develop dyeing the local product of cotton fabrics in order to be available for all functional and economic requirements in our society.
3- Completion of studying physical and mechanical properties of the different types of other cotton fabrics that are not used by the research.
4- using microwave ovens as well as rays in finishing and dyeing fabrics so as to reduce the consumed energy through other traditional methods by modifying the fiber properties comparing to other traditional methods as they are Eco-friendly and do not result in environmental contamination.

References:

(1) **Kadolph, S.J. & Langford, A.L.:** Textiles. Upper Saddle River, NJ: Person Education, Inc., (2002).

12/11/2013

(2) Ahmed Fouad Al Nagawy, technology of cotton fabrics finishing(preparation, dyeing, finishing), mansheat Al Maref. Alexandria, (1986).

(3) **Erhan, O.; Inci, B. & Kamil, A.**: "use of ultrasonic energy in reactive dyeing of cellulosic fabrics", Journal of the society of dyers and colourists, Vol. 111, issue 9, pp. 279- 281, Oct. (2008).

(4) **Metaxas, A.C. & Meredith, R.J.:** "Industrial microwave heating", Peter Peregrinus, 111 – 150, (1983).

(5) **Reis, A.H. & Miguel A.F. (eds.):** An experimental study on dyeing of polyester with microwave heating", Application of Porous Media (ICAPM) 245 – 248, (2004).

(6) **Katovic D.,S.B. Vukusic, S. Hrabor and J. Bartolic,:** "Microwave device for thermal treatment of cellulose materials", Textile Days Zagreb, 191 – 192, (2005).

(7) **Anonimno:** "Microwave processes for the combined desizing, scoring and bleaching of grey cotton fabrics", J. Text. Institute, 3, 602 – 607, (1996).

(8) **Hou, A.; X. Wang & Wu, L.:** "Effect of microwave irradiation on the physical properties and morphological structures of cotton cellulose", Carbohydrate Polymers, 74, 934 – 937, (2008).

(9) **Katovic, D.; Vukusic, S.B.; Hrabor, S.; Bartolic, J.:** "Microwaves in chemical finishing of textiles", 18th International Communications, (ICE com), Dubrovnik, Croatia, Conference Proceedings ISBN 953-6037-44-0, pp. 255- 258.

(10) **Murugan, R., M. Senthilkumar, T. Ramachandran:** "Study on the possibility of reduction in dyeing time using microwave oven dyeing technique", IE (I), Journal-TX, Vol. 87, 23 – 27, February (2007).

(11) **Rehab G. I. A. El-H.**:" The Effect of Cellulosic Fabrics Treatment by Microwave on the Functional Properties for Ready-made Clothes and Improvement its Dyeability" Ph.D. of Faculty of Specific Education Tanta University, 2011.

(12) **Reis, A.H. & Miguel A.F. (eds.):** An experimental study on dyeing of polyester with microwave heating", Application of Porous Media (ICAPM) 245 – 248, (2004).