



Research article

Exploitation of seawater for cotton and polyester fabrics colouration

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ABSTRACT

Water is the ultimate and mostly used media during textile materials processing, especially in colouration. This study investigated the possibilities of using seawater for cotton and polyester fabrics dyeing. Single jersey fabrics made of 100 percent cotton and polyester were dyed using a standard recipe and two separate water source as dyeing mediums. It has been focused on the assessment of colour fastness to wash, perspiration, saliva, rubbing, water, light and colour difference value due to compare the efficiency of dyeing media. The results revealed that the cotton fabric dyed with seawater showed lighter shade than that of ground water sample. But for polyester fabric darker shade was obtained compared to ground water. The cotton sample dyed with sea water carried about 15% higher colour strength than ground water dyed sample but for polyester it was very negligible, only 3%. Moreover, the results of colour fastness to wash, perspiration, saliva, rubbing, water and light for seawater dyed samples of cotton and polyester were shown satisfactory outcomes having the grading of 4–5 in most of the cases. This exploration established that commercial dyeing processes were robust and can be practically transferable into the seawater medium for cotton and polyester fabrics.

1. Introduction

About 71% of earth's surface is ornamented with water where only 1% of this water is fresh and suitable for humans for drinking [1]. Actually, seas and oceans consume about 96.5% of water on Earth where ground water consumes 1.7% and 1.7% of the water is in the ice caps. So, about 2.5% of this water is fresh, where 98.8% of that water is in ice caps or in ground layer [2, 3]. From this scenery, it is clearly visible that there is a huge scarcity of fresh water all over the world.

About all of the textile industries in Bangladesh using the underground water for textile wet processing due to its ready availability and cost-effectiveness. Obviously, it consumes a large quantity of water for this purpose because there is a series of operation involved with textile wet processing e.g., scouring, bleaching, dyeing and finishing. So, day by day the ground water level is decreasing rapidly. These types of activities may cause serious threat for our next generation [4, 5]. Nearly, 70–150 L of fresh water is required to dye 1 kg of cotton fabric [6, 7].

Consequently, the water consumption of a dyeing industry having capacity 8 tons/day is about 880000 L per day. So, it is a high time to look forward in order to use surface water for industrial purposes.

The surface water may come from rivers, canals and seas. Due to the ready availability and cheapness, water has been used almost in textile processing as medium. Seawater would serve as an alternative source of water in order to minimize the load of using ground water. But salinity is the main reason to use seawater for industrial purposes. Seawater has a salinity of 3.5% as well as denser than ground water due to presence of dissolved salts [8]. So, it would be supportive for the salt involvement cost during the dyeing process because huge amounts of salt are required for dyeing treatment. Seawater may be one of the great opportunities and alternative resources for the dyeing sector as a dyeing medium. The advantages of seawater over the normal ground water are- its low cost, easily available near the coastal area. For this reason, as a dyeing medium, seawater would capture an important position beside the ground water.

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For dyeing of cotton goods reactive dyes are so much suitable and extensively used and whereas dyeing of polyester goods disperse dyes are used in the textile dyeing industries due to have good colour fastness properties and a wide range of shade can be achieved by these dyes [9, 10, 11]. Because, the fastness properties of cotton knitted fabric are affected by its shade percentages [12].

Studies found that while introducing of seawater as a reactive dyeing media, the dyed fabrics give comparatively lighter shade along with no significant difference for various colour fastness parameter compared to ground water dyed sample. As the parameters of sea water dyed samples remain unchanged, so it may encourage the use of sea water as reactive dyeing media on a larger scale [12, 13, 14].

A few researchers have worked on seawater for cotton colouration [8, 14, 15, 16]. Unfortunately, all of them have been analyzed only for cotton fabric. No work has been identified for polyester fabric colouration with seawater including comparison of cotton colouration. In this work, the aim was to utilize the seawater in dyeing of cotton and polyester fabric as well as compare the performances of dyed fabric using ground water. Colour fastness to wash, perspiration, saliva, rubbing, water and light of dyed samples were reported to evaluate the performance. The colour strength and colour coordinates were also investigated.

2. Materials and methods

2.1. Materials

Fabric used in this experiment includes 100% cotton and polyester of single jersey weft knitted structure having an areal density of 160 g per square meter. Fabric was collected from “Hi-Fashion Composite Textiles Ltd”, Joydeppur, Gazipur, Bangladesh. The seawater was collected from Cox's Bazar sea beach. The qualities of water used in this study are pointed out in Table 1.

Reactive dyes such as Remazol Red RR, Remazol Yellow RR, and Remazol Blue RR and disperse dyes such as Livafix Fast Red CA, Livafix Yellow CA and Livafix Amber CA were collected from Dyestart Chemicals Ltd, Singapur. Besides, detergent (Jinterge Eco KS-90s), sequestering agent (Jintexy Eco SQ-114 Fe), bleaching agent (Hydrogen peroxide-50%), stabilizer (Kappazon H53-250), scouring agent (Caustic soda), leveling agent (Jinlev Eco CL-225), electrolyte (Gluber salt), soaping agent (Jinsop Eco AW-501), dispersing agent (Jinlev RLF-349), reductive agent (Hydrose), neutralizer (Acetic acid) were collected from Redox Chemicals Ltd, Srilanka. These commercial dyes and chemicals were used without any rectification.

Table 1 shows the parameters of ground and sea water that has been used in this study. Seawater is very similar to fresh water unless it contains dissolved salts. Due to the presence of these salts, seawater shows salinity which is a very important aspect [17]. From the significant analysis of seawater, a known complex solution containing chlorine (55.0%), sulfate (7.7%), sodium (30.7%), magnesium (3.6%), calcium (1.2%) and potassium ions (1.1%) has been found [18, 19]. So, it is obvious that the main difference between freshwater and seawater is the amount and types of dissolved salts in its composition [20]. This will make a huge difference while using seawater as a medium of colouration, considerably influences the dyeing behavior.

2.2. Methods

2.2.1. Pretreatment and dyeing

Scouring and bleaching was carried out at Infra-red lab sample dyeing machine (Xiamen Rapid, China) and schematic diagram presented in Figure 1. The recipe of scouring and bleaching mentioned in Table 2. Dyeing of cotton fabric was carried out conferring to the exhaust method at Infra-red lab sample dyeing machine (Xiamen Rapid, China) at 60 °C for 60 min using ground and seawater separately. Then the dye bath was cooled at 40 °C and samples were washed at room temperature. Samples were squeezed and air dried in flat dryer machine (Mesdan, Italy). Then,

the after treatment was performed by 0.8 g/l acetic acid at 55 °C for 10 min and by 0.8 g/l Jinsop Eco AW-501 at 80 °C for 10 min. In case of dyeing and after treatment material to liquor ratio maintained as 1:20. The recipe of cotton dyeing stated in Table 3 and Figure 2 indicates the schematic diagram of the dyeing and after-treatment process for cotton fabric.

Dyeing of polyester fabric was also done on the same sample dyeing machine at 130 °C for 40 min. The polyester fabric was treated with Jinterge Eco KS-90 s at 90 °C for 10 min before adding dyestuffs. Reduction cleaning is important for polyester fabric dyeing and it was done by 2 g/l caustic soda and 2 g/l hydrose at 90 °C for 20 min. The material to liquor ratio was also maintained as 1:20 for polyester fabric dyeing and reduction cleaning. The recipe of dyeing for polyester stated in Table 4 and the dyeing and after-treatment process for polyester fabric illustrated in Figure 3. The ground and seawater were used as medium in all processing steps such as pretreatment, dyeing and after treatment for all specimens.

2.2.2. Sampling

Dyed samples are identified as stated in Table 5.

2.2.3. Testing of colour fastness

Evaluating various colour fastness properties of the selected dyed fabric, standard methods were employed [21]. Colour fastness to wash, rubbing (dry and wet), water, perspiration, light and saliva were assessed visually by using grey scale of colour change and staining.

2.2.3.1. Colour fastness to wash. Colour fastness during washing is one of major criteria to determine the quality of dyeing. Detergent washing testing refers to the hindrance of colours to laundering process [22]. The test condition stated in Table 6 was maintained in this study.

2.2.3.2. Colour fastness to rubbing (wet and dry). The rubbing test determines the hindrance of textile colours to abrasion off and tinctures another surface. The samples were tested with ISO 105-X12:2016 [23] method where the test samples are rubbed with a dry and wet crocking cloth. The rubbing tester is also named as “crock meter” where force and abrasion are performed by rubbing finger under a definite condition stated in Table 7.

2.2.3.3. Colour fastness to water. Colour fastness to water evaluates the hindrance of textile colours to immersion in water as well as the migration of colour from surface to surface. The samples were tested with EN ISO 105-E01:2013 [24], where a strip of multifiber fabric specimen attached with the test samples to measure staining under a specific condition stated in Table 8.

2.2.3.4. Colour fastness to perspiration/saliva. Here the samples were tested by ISO 105-E04:2013 [25] method. The testing procedures of acid and alkali perspiration, and saliva are same as the testing of colour fastness to water. The basic difference is on the making of recipe. Recipe and testing conditions for acid and alkali perspiration test are stated in Table 9 where Table 10 illustrates condition of saliva test.

Table 1. Parameters of water used.

Parameters	Amount/level	
	Ground water	Seawater
pH	7.26	7.87
Hardness	55 PPM	750 PPM
Total Dissolved Solid (TDS)	211 PPM	1307 PPM
Sodium	50 mg/l	4000 mg/l
Chloride	300 mg/l	7500 mg/l

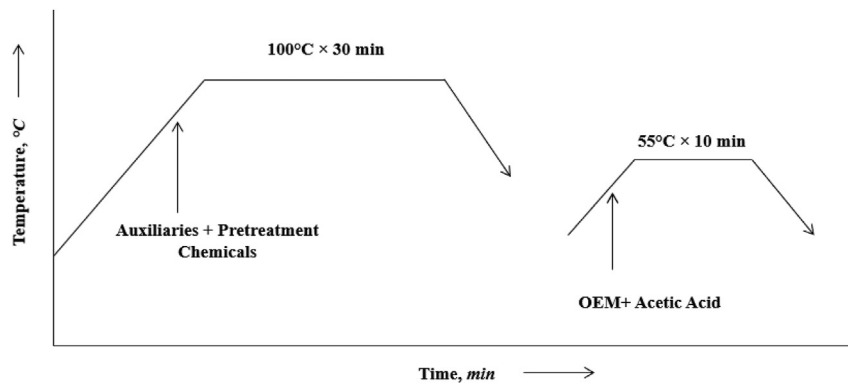


Figure 1. Schematic diagram of pretreatment process for cotton fabric.

Table 2. Scouring and bleaching recipe for cotton.

Chemicals	Concentration (g/l)	Remarks
Jinterge Eco KS-90s	0.5	100 °C × 30 min.
Jintexy Eco SQ-114 Fe	0.5	
Caustic soda	2.0	
Hydrogen peroxide (50%)	2.0	
Kappazon H53-250	0.4	
Jintexyme OEM	0.4	55 °C × 10 min.
Acetic acid	0.5	

2.2.3.5. Colour fastness to light. The colour fastness to light test evaluate the effect of sunlight on textile colours. In presence of light, textile colourants absorb a certain wavelength and then prone to some fading. Internationally, EN ISO 105-B02: 2013 [26] is a popular standard for determining colour fastness to light. Blue wool reference along the definite condition mentioned in Table 11 is used to determine the fading to tested sample and the rating ranges from 1 to 8 whereas 1 corresponds to very poor and 8 refers to excellent colour fastness.

2.2.3.6. Determination of colour strength. The colour strength (K/S) value of the dyed samples was assessed by a data colour spectrophotometer based on Eq. (1) narrated from Kubelka-Munk theory of reflectance [27].

$$\frac{K}{S} = \frac{(1 - R)^2}{2R} \quad (1)$$

Where, R is reflectance of an incident light from the dyed material, K is absorption and S is scattering coefficient of the dyed fabric.

2.2.3.7. Determination of colour coordinates value. The colour coordinates of the dyed samples were determined based on the CIE Lab

Table 3. Dyeing Recipe for cotton.

Dyes/Chemicals	Concentration (g/l)	Remarks
Jinlev Eco CL-225	1	60 °C × 60 min.
Reactive Red	1	
Reactive Yellow	0.5	
Reactive Blue	0.5	
Gluber salt	60	
Soda ash light	15	

Concentration of dye is expressed in % on weight of the fabric (% owf).

system via dual beam reflectance Data-colour Spectroflash (SF 650X, USA) keeping the setting: Illuminant D65, Medium area view, Specular included and CIE 1964 supplementary standard observer (10° observer). Each sample was folded twice to give an opaque view with four plies and the colour coordinates value was measured automatically for only one time [28]. The measurement was repeated three (3) times and then recorded average value. The identifying parameters for colour differences using CIE L*a*b* coordinates are like as L* indicates lightness, a* is the red/green coordinate, and b* is the yellow/blue coordinate. Deltas for L* (ΔL^*), a* (Δa^*) and b* (Δb^*) may be positive (+) or negative. The total difference, Delta E (ΔE), however, is always positive.

3. Results and discussion

3.1. Colour fastness to wash

Colour fastness to wash was introduced to evaluate the colour change of produced sample as well as the colour staining. Table 12 presents the outcomes of colour fastness to wash for dyed samples. The overall results of colour fastness to wash of samples were very good to excellent.

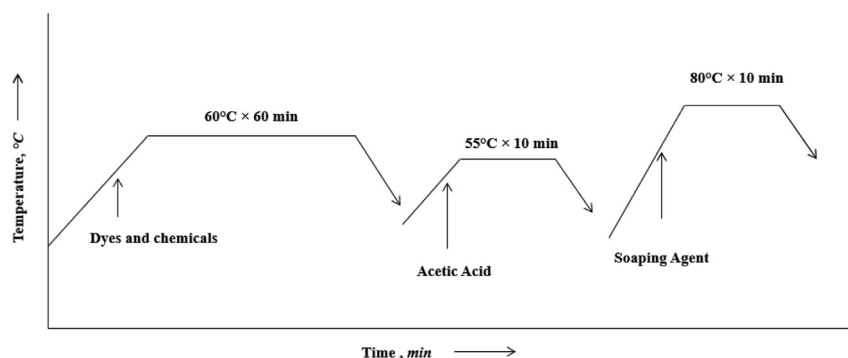


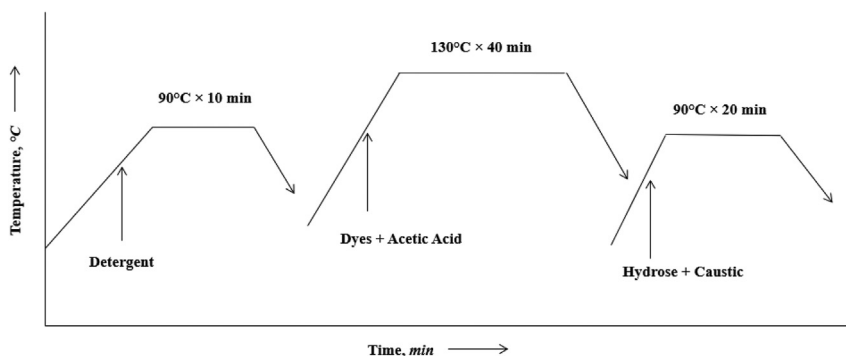
Figure 2. Schematic diagram of dyeing and after-treatment process for cotton fabric.

Table 4. Dyeing recipe for polyester.

Dyes/Chemicals	Concentration (g/l)	Remarks
Jinterge Eco KS-90s	1	90 °C × 10 min.
Jinlev RLF-349	1.5	130 °C × 40 min.
Acetic acid	1	
Disperse Red	0.5	
Disperse Yellow	0.25	
Disperse Navy	0.25	

Concentration of dye is expressed in % on weight of the fabric (% owf).

CGW, CSW, PGW and PSW were shown to change in colour due to wash and results indicate the good to excellent grade (see in Table 12). But considerably staining has ascended on nylon for PGW. Simultaneously, slightly staining was observed on all multi-fibre except polyester for PGW and PSW. However, cotton samples dyed with sea and ground water exhibited better wash fastness grade in staining compared to polyester samples dyed with sea and ground water but the same scenario was noticed for all specimens in colour change (see in Table 12). The seawater dyed sample gives a distinctly higher rating because the fixation of dye molecules is better in this medium. For cotton fabric, the reason might lie in ionic phenomenon between dye and fibre. Basically nucle-

**Figure 3.** Schematic diagram of dyeing and after-treatment process for polyester fabric.**Table 5.** Samples identification.

Fabric type	Dyeing medium	Identification code
Cotton	Ground water	CGW
	Seawater	CSW
Polyester	Ground water	PGW
	Seawater	PSW

ophilic addition of dye sites (functional group) with protonated groups of cellulose may enhance the dye exhaustion into the cotton fabric. Here, vinyl sulphone reactive dyes were employed. In the presence of alkali, the cellulose fibre gives acid disassociation reaction. By this reaction cellulose along with a protonated group stays in dye bath and may accelerate its reaction with dyes.

Table 6. Condition during washing.

Dimension of sample	Detergent (g/l)	Sodium perborate (g/l)	Water (ml)	No. of steel ball	Temperature (°C)	Time (min.)
10 cm × 4 cm	4	1	150	25	50	30

Table 7. Condition during rubbing test.

Dimension of Sample	Size of abrasive finger (mm)	Downward force (N)	Wet Pickup for wet rubbing (%)	No. of cycles/turns
14 cm × 5 cm	(16 ± 0.1)	(9 ± 0.2)	95–100	10 complete turns @ 1 turn/sec

Table 8. Condition during colour fastness to water test.

Dimension of Sample	Immersion time (min.)	Water temperature (°C)	Drying condition
10 cm × 4 cm	15 min.	Room temperature	(37 ± 2) °C for 4 h under a pressure of 12.5 Kpa

Table 9. Recipe and testing condition for perspiration test.

Sample size	Solution	C ₆ H ₉ O ₂ N ₃ .HCl.H ₂ O	NaCl	Na ₂ HPO ₄ .2H ₂ O	Drying condition
10 cm × 4 cm	Alkali: pH 8	0.5 gm	5 gm	2.5 gm	(37 ± 2) °C for 4 h under a pressure of 12.5 Kpa
	Acid: pH 5.5	0.5 gm	5 gm	2.2 gm	

All the amount of recipe based on 1 L of distilled water.

Table 10. Recipe and testing condition for saliva test.

Sample size	Lactic acid	Urea/carboamide	NaCl	KCl	NH ₄ Cl	Na ₂ SO ₄	Drying condition
10 cm × 4 cm	3 gm	0.2 gm	4.5 gm	0.3 gm	0.4 gm	0.3 gm	(37 ± 2) °C for 4 h under a pressure of 12.5 Kpa

All the amount of recipe based on 1 L of distilled water.

Table 11. Testing condition for colour fastness to light.

Dimension of Sample	Relative humidity (%)	Black panel temperature (°C)	Irradiance at 420 nm	Time (hr)
13 cm × 4.5 cm	50	50	(1.1 ± 0.02) W/m ² /nm	24

3.2. Colour fastness to perspiration (acid/alkali)

Tables 13 and 14 illustrates the evaluation of fastness to perspiration. The overall results of colour fastness to perspiration of samples in both alkaline and acidic medium were very good to excellent.

It is necessary to evaluate the rating of perspiration fastness as perspiration is an agency that can destroy the colour from the fabric surface. All the samples were shown in the same rating (good to excellent) in case of change in colour as well as staining excluding PGW due to alkaline perspiration. Slightly colour change occurred only for PGW (see in Table 13). On the other hand, for acidic perspiration no samples were shown different grades and indicated well to excellent grade (4–5) which is clearly demonstrated in Table 14. The reason for higher perspiration rating for all dyed material is that the dyes have excellent withstands capacity against the activity of acid and alkali perspiration.

3.3. Colour fastness to saliva

Table 15 presents the colour fastness to saliva. The overall results of colour fastness to saliva of samples were very good to excellent.

No changes appeared for CSW and PSW due to the introduction of seawater instead of ground water. The all dyed specimens i.e. CGW, CSW, PGW, and PSW were shown good to excellent grades in colour change and staining against saliva (see in Table 15). The reactivity level of dye

molecules with fabrics is higher than that of saliva that's why all dyed samples showed higher saliva rating.

3.4. Colour fastness to rubbing and light

The grade of colour fastness to rubbing and light of the samples are listed in Table 16. The overall results of colour fastness to rubbing of samples are very good to excellent. Wet rubbing properties are shown lower than dry rubbing.

CGW and CSW showed excellent dry rubbing and good wet rubbing properties whereas PGW and PSW were same in dry and wet rubbing. However, both cotton and polyester samples dyed with seawater were indifferent in grading compared to the samples dyed with ground water (see in Table 16). Table 16 infers that the rub fastness ratings are equal for seawater dyed material compared to ground water dyed fabrics. This might be happened due the higher dye fixation into the fibre through a dye-fibre strong bond formation. In water, reactive dyes and cellulose fibers both are electronegative. So, there is an electrostatic repulsion between them. To minimize this repulsion, a dyeing promoter must be used. During cotton dyeing with reactive dyes, different salt serves as a dyeing promoter. The positive charge of salt shows electrostatic attraction to cellulose fibers and adsorbed by cellulose fibers. Thus, the presence of salt increases the exhaustion of dyes to the cellulosic fibre and followed by enhance the fixation rate of dyes into the fibre [29]. It has been found that sea water contains sodium, magnesium, calcium and

**Figure 4.** Images of dyed samples.

Table 12. Colour fastness to wash.

Sample code	Change in Colour	Staining					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
CGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
CSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PGW	4-5	4	4	2-3	4-5	3	4
PSW	4-5	4	4	3	4-5	3	4

Table 13. Colour fastness to perspiration (alkaline).

Sample code	Change in Colour	Staining					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
CGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
CSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PGW	4	4-5	4-5	4-5	4-5	4-5	4-5
PSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5

Table 14. Colour fastness to perspiration (acidic).

Sample code	Change in Colour	Staining					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
CGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
CSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5

Table 15. Colour fastness to saliva.

Sample code	Change in Colour	Staining					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
CGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
CSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5

potassium ions [18, 19]. So, these ions are also act as the positive site as like as the positive site of salt. Therefore, using seawater along with Glubers salt facilitates the exhaustion rate of dyes into the cellulosic fibre and gives better rubbing fastness.

In presence of light, textile colourants absorb a certain wavelength and then prone to some fading. So, the rating of colour fastness to light is also a major concern. Regarding light fastness, the sample orders were found as CGW < CSW < PGW/PSW. So, this order proclaimed that the seawater dyed cotton fabric displayed higher light fastness values than that of ground water dyed sample. Significant fading occurred for CGW during light exposure. But the value was unchanged for polyester dyed samples in both sea and ground water medium (see in Table 16). The reason for the improvement of light fastness in case of seawater dyed

cotton fabric is that seawater contains comparatively more metal components which may present on the surface of the dyed sample and interfere with the fading during exposure to light [21].

3.5. Colour fastness to water

Table 17 illustrates the grading of colour fastness to water. The overall results of all samples were shown very good to excellent.

In case of colour fastness to water, no samples were in different grades for colour change and staining. Good to excellent grade was obtained by applying both seawater and ground water as dyeing medium simultaneously (see in Table 17).

Table 16. Colour fastness to rubbing and light fastness.

Sample code	Rubbing fastness		Light fastness
	Dry rubbing	Wet rubbing	
CGW	5	4	3
CSW	5	4	4-5
PGW	4-5	4-5	4-5
PSW	4-5	4-5	4-5

Table 17. Colour fastness to water.

Sample code	Change in Colour	Staining					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
CGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
CSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PGW	4-5	4-5	4-5	4-5	4-5	4-5	4-5
PSW	4-5	4-5	4-5	4-5	4-5	4-5	4-5

Table 18. Colour co-ordinate values of tested samples.

Standard	Sample batches	Illuminant/Observer	L*	a*	b*	C*	H*	ΔE	Metamerism Index
CSW	CGW	D65/10 Deg	-2.02	-0.47	1.15	-0.92	0.83	1.55	-
		TL83/10 Deg	-2.01	-0.48	1.22	-1.01	0.84	1.63	0.13
PSW	PGW	D65/10 Deg	0.69	0.31	0.65	0.53	0.48	0.56	-
		TL83/10 Deg	0.71	0.26	0.71	0.61	0.45	0.59	0.08

[Here, L* = Lightness, a* and b* = Parameters of colour difference, C* = Saturation, H* = Tone, ΔE = Colour difference].

3.6. Measurement of colour co-ordinates

The colour coordinates of the dyed samples were evaluated by a spectrophotometer using D65, TL83 illuminant and 10° observer settings considering the seawater dyed samples as standard and others as sample batches. The colour co-ordinate values of tested samples are given in Table 18.

Table 18 depicted that the total colour difference value is out of range i.e. more than 1 for cotton dyed fabrics. Hence the result of colour matching is rejected. On the other hand, the total colour difference value is in the range of 1 i.e. the result is accepted for colour matching for polyester dyed fabrics with seawater medium. It has been also observed that for the same recipe in cotton fabrics dyeing, dyes absorption is less for seawater dyed samples than ground water dyed samples whereas polyester fabrics absorb more dyes in seawater medium and shade difference with ground water treated fabric is in the acceptable range. The physical appearance of CGW, CSW, PGW and PSW are illustrated in Figure 4.

The dyeing behavior of cotton fabric completely depends on the interaction between fibre and dye molecules. So, the medium of dyeing plays a vital role during cotton dyeing as a medium influences the movement of reactive dyes. It is well known that seawater contains comparatively more metal and the hardness of seawater is also very high due to the presence of these metals. The hardness of seawater is the major factor that influences the dyeing characteristics of cotton fabric, and may lead to poor shade and poor quality of dyed samples.

On the other hand, there is no chemical interaction between dye and fibre for polyester fabric dyeing like cotton. Disperse dyes are physically bound into polyester fibre which is facilitated by free volume of polymer molecules by means of high temperature. So, the dyeing medium has a little influence on the characteristics of dyeing.

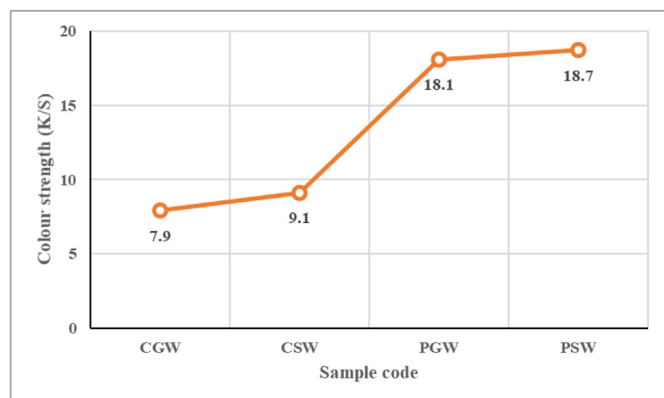
3.7. Colour strength (K/S)

Colour strength of all dyed samples was measured by reflectance spectrophotometer using Kubelka-Munk theory of reflectance. Figure 5 illustrates the colour strength of dyed samples.

The order of colour strength values for cotton samples were found as CGW < CSW and for polyester PGW < PSW. The K/S value of CGW, CSW, PGW, and PSW were 7.9, 9.1, 18.1 and 18.7 respectively. Colour strength was increased for both cotton and polyester dyed specimens while seawater was used as medium. The maximum colour strength has been noticed at 560 nm for cotton fabrics and at 520 nm for polyester fabrics. The colour strength was increased 15.19% for cotton while dyed fabrics as seawater medium compared with dyed samples as ground water. On the other hand, the colour strength was increased 3.31% for polyester while dyed fabrics as seawater medium compared with dyed samples as ground water. So, colour yield significantly increased for seawater dyed materials for cotton fabric rather than polyester (see in Figure 5). Seawater contains sodium, magnesium, calcium and potassium ions [18, 19]. These ions minimize the electrostatic charge between dyes and fibre. Thus, they serve as a dyeing promoter. So, the presence of ions increases the exhaustion of dyes onto the cellulosic fibre and followed by enhance the fixation rate of dyes into the fibre [29]. Finally, gives the shade with higher colour strength.

4. Conclusions

Cotton and polyester are the most common and popular fabric. So, the dyeing of cotton and polyester consume huge amount of ground water and thereby the searching of an alternative water source is the demand of time. This project describes the influence of seawater on cotton and polyester fabric dyeing with reactive dyes and disperses dyes respectively. The result shows that seawater dyed cotton fabric with 2% of reactive dyes are lighter than ground water dyed samples whereas seawater dyed polyester fabric with 1% of disperse dyes are darker than ground water dyed samples with an acceptable range. It is visualized that wash, perspiration, saliva, rubbing, water, light fastness is very good for both fabric samples. This exploration established that commercial dyeing

**Figure 5.** Colour strength (K/S) dependence on dyeing medium.

processes were robust and can be practically transferable into the seawater medium.

Declarations

Author contribution statement

Md. Rezaul Karim: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Tarikul Islam, Muhammad Abdur Rashid, Mohammad Abdul Jalil: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Md. Reazuddin Repon: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data included in article/supplementary material/referenced in article.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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