

## RESEARCH ARTICLE



# A Sustainable Denim Washing Process Uses Coconut Husk Instead of Conventional Stone

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**Md. Eanamul Haque Nizam<sup>1\*</sup>, Badhan Chandra Roy<sup>2</sup>,  
Md Ramzanul Islam Emon<sup>2</sup>, Kazi Yusuf Bin Showkat<sup>2</sup>**<sup>1</sup> Assistant Professor, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh<sup>2</sup> B.Sc. (Engr.), Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh

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\* **Corresponding author.**

[eanamul.nizam@seu.edu.bd](mailto:eanamul.nizam@seu.edu.bd)

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## Abstract

**Objectives:** The main aim of this study is to ensure sustainability in the garment washing sector by replacing stone wash with coconut husk. **Methods:** The authors just replace stone with coconut husk in the conventional recipe. Three types of denim fabric have been used to test these experiments. 220-400gsm denim fabric has been chosen for these experiments with 200-300 gm coconut husk. There are different types of sustainable chemicals like Asucel wf (waterless enzyme), Lanzene Row A2 (activator) and Novopool SE 550 powder has been used. **Finding and Novelty:** Denim washing with coconut husk provides positive feedback, like stone washing. The using of coconut husk reduces the liquor ratio compared to conventional stone denim washing because of absorbency properties of coconut husk. Results reveal the satisfactory values in acid and alkali medium because of good absorbency properties of coconut Husk. After washing with coconut shell meet the minimum requirements of dimensional stability (Length $\pm$ 3%, width $\pm$ 3%) compared to stone denim wash. The tearing strength and tensile strength also meet the minimum requirements ( $\geq$ 30 N and  $\geq$ 250 N) compared to stone denim washing. Introducing the alternative in denim stone washing, the coconut husk shows a perfect result rather than stone one without compromising the trendy looks.

**Keywords:** Coconut; Stone; Denim; Sustainability; Physical and mechanical properties

## 1 Introduction

Sustainability is the ability to exist and develop without depleting natural resources for the future. Washing garments enhances visual appeal; denim clothing is the first sector to experience growth in terms of softness, conformability, and fashion looks<sup>(1)</sup>. Nowadays denim garments has drowned a special look of effect in garments<sup>(2)</sup>. Stone

washing, caustic washing, sandblasting, towel washing, moon washing, ice washing, scrubbed appearance washing, damaged look washing, plasma therapy, and ultrasonic polishing and finishing are a few of the mechanical and/or chemical procedures that produce these washing effects<sup>(3,4)</sup>. Due to the degree of size and form variation, traditional pumice stone wash is frequently utilized in the denim industry. The volcanic rock known as pumice, which floats on water and is hydrophilic, often originates in Indonesia and Turkey. Even though stone is frequently used for washing, it has several issues. As a concrete example, stone causes fabric strength to decrease because of machine wear and tear<sup>(4)</sup>, grit deposition on the environment and in the effluent plant, an increase in labor costs to remove the stone powder from the pockets, wear, and tear for expensive washing machines, etc.<sup>(5,6)</sup>. To avoid using stone, experts are looking for acceptable substitutes<sup>(7)</sup>. In garments washing sector ensure the environmental sustainability every factory maintaining low liquor ratio in their computerized automatic front-loading machinery. For maintaining sustainability, maximum factories of Bangladesh are using meta-flow, ozone & laser machines. Also, they are using Environmental Impact Measuring (EIM) software by which they are saving huge amounts of water, chemicals & energy usage as well as minimizing impact on worker health<sup>(7)</sup>. The cost of garments denim wash is little bit more after using this technique because of machine set up cost, maintenance cost, operating cost. But in global market, the buyer is more concern about the price of the wash cost<sup>(8)</sup>. There is huge amount of research has conducted to reduce the total amount of cost per garments. Coconut husk is the most recent development in this area. The only extant species of the genus *Cocos* is the coconut tree (*Cocos nucifera*), which belongs to the Aceraceae family of palm trees. The word "coconut" (or the obsolete "cocoanut") can refer to the entire coconut palm, the seed, or the fruit, which is a drupe and not a nut according to botanical definitions. The word "coco" originally meant "head" or "skull" in old Portuguese, and it was given that name because of the three depressions on the coconut husk that mimic facial features<sup>(9)</sup>. There is disagreement over the coconut's evolutionary origins, with some speculating that it may have originated on islands in the Pacific, South America, or Asia. Indonesia, the Philippines, and India generate around 75% of the world's coconuts<sup>(9-11)</sup>. In this study, the authors try to replace the use of conventional pumice stone because of price and costing of denim washing to ensure future sustainability. There are various drawbacks to pumice stone washing that have been discovered in denim production around the world<sup>(11)</sup>. To address these issues, this project tried to replace stone with a coconut husk and studied its tensile strength, tearing strength, gram per square meter, etc.

## 2 Methodology

### 2.1 Materials

#### a) Coconut husk preparation

Coconut husk has collected from the coconut which is purchased (Dry Conditions) from the local market of the Bangladesh for the investigation. Only dry Coconut husk is collected for the garment's denim wash because of their high strength and modulus properties. An approximate value of coconut husk density is  $1.60 \text{ g/cm}^3$ <sup>(12-14)</sup>.

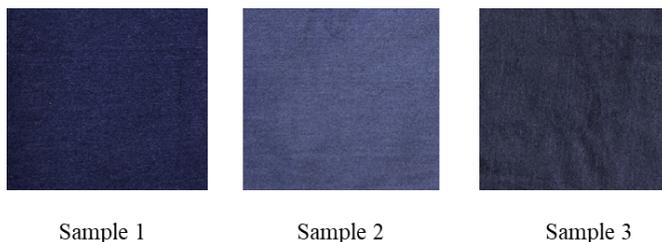


Fig 1. Coconut husk in local market

#### b) Fabric Criteria

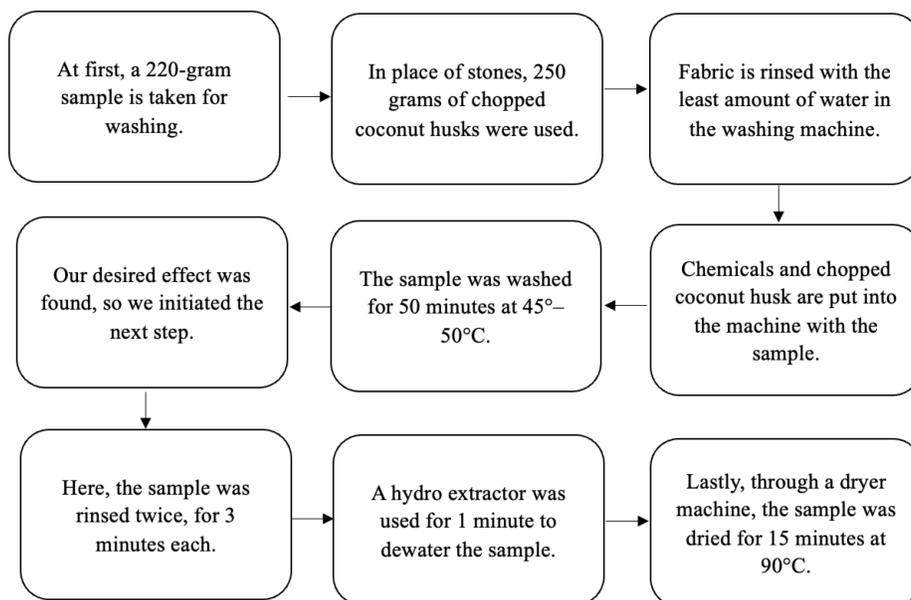
**Table 1. Types of the fabrics used in this study**

Sample no	Types of Denim Fabric	GSM	Compositions %
1	Pure Indigo	330	90% COTTON/ 8% POLYESTER/ 2% ELASTEN
2	Grey	350	88% COTTON/ 10% POLYESTER/ 2% ELASTEN
3	Indigo Carbon	415	82% COTTON/ 17% POLYESTER/ 1% ELASTEN



**Fig 2. Sample Picture**

**2.2 Method**



**Fig 3. Methodological flow chart**

In this study, three types of denim fabrics have taken which GSM is 220. At first, the coconut husk has prepared by above process from the local market of Bangladesh. Then the coconut husk is cut into different pcs (10 cm) each for wash bath. 250 gm coconut husk has taken for the washing batch as per fabric weight. Different types of chemicals have taken as per required for recipe. After 50 mints run the machine sample has collected from the wash batch. In the below (Figure 3) stated the brief flow of the operations.

### 2.3 Recipe

Sample : 220-400 gm denim cloth (3 types of samples)

Material : 250gm-300 gm coconut husk.

Chemical : Asucel wf (waterless enzyme)

Lanzene Row A2 (activator)

Novopol SE 550 powder

Time : 50 minutes.

Temperature : 45° - 50°C.

Rinse : 2 times for 3 minutes.

Hydro : 1 minute.

Dryer : 15 minutes 90°C.

### 2.4 Testing standard

To evaluate different physicals and mechanicals properties of raw and washed samples the testing method, gathered in Table 2, are used in the research.

**Table 2. Testing standard**

Test Names	Testing standard
Dimensional Stability To washing	EN ISO 6330 <sup>(15)</sup>
CF To Rubbing {Dry and wet}	EN ISO 105-X12 <sup>(16)</sup>
CF To washing	EN ISO 105-E01 <sup>(17)</sup>
CF To water	EN ISO 105-C06 <sup>(18)</sup>
CF To Perspiration	EN ISO 105-E04 <sup>(19)</sup>
Fabric Weight (GSM)	ASTM D3776 <sup>(20)</sup>
Tear Strength	EN ISO 13937-2 <sup>(21)</sup>
Tensile Strength	EN ISO 13934-2 <sup>(21)</sup>

## 3 Results and Discussion

### 3.1 Conventional stone enzyme denim wash for three types of samples

**Table 3. Conventional results for three types of samples**

Name of the Tests	Direction /Types	RESULTS			Requirements	Comments
		Sample 1	Sample 2	Sample 3		
<b>Dimensional Stability To washing</b>	Length	0.52%,	0.56%	0.92%	<b>Length±3%, width±3%</b>	<b>Pass</b>
	Width	0.57%	0.47%	0.67%		
<b>CF To Rubbing {Dry and wet}</b>	Before	4	4-5	4	<b>3-4</b>	<b>Pass</b>
	After	4	4-5	4-5		
<b>Appearance {1 time wash}</b>		3-4	3-4	3-4	<b>3-4</b>	<b>Pass</b>
<b>CF To water</b>		4-5	3-4	3-4	<b>3-4</b>	<b>pass</b>
<b>CF To Perspiration</b>	Acid	4-5	4-5	4-5	<b>Alkali=3, Acid=3</b>	<b>Pass</b>
	Alkali	4-5	4	4-5		
<b>Fabric Weight (GSM)</b>		338 (After wash)	365 (After wash)	424 (After wash)	<b>&gt;300</b>	
<b>Tear Strength (As Received)</b>	Warp	43.56 N	43.56 N	41.56 N	<b>&gt;30 N</b>	<b>Pass</b>
	Weft	50.56 N	35.56 N	49.56 N		
<b>Tensile Strength</b>	Warp	530.00 N	380.00 N	430.00 N	<b>&gt;250 N</b>	<b>Pass</b>
	Weft	400.00 N	426.00 N	450.00 N		

From Table 3, we can see that three sorts of samples have been taken for stone enzyme denim wash. In the factory, the equal washing bath was once used to wash the samples. From the statistics proven in Table 2, it is evident that the output is very positive. The exchange in more than one check effects has come about in accordance with cloth types, which meet the primary necessities of the check to be last passes in accordance with consumer requirements.

### 3.2 Shrinkage Test

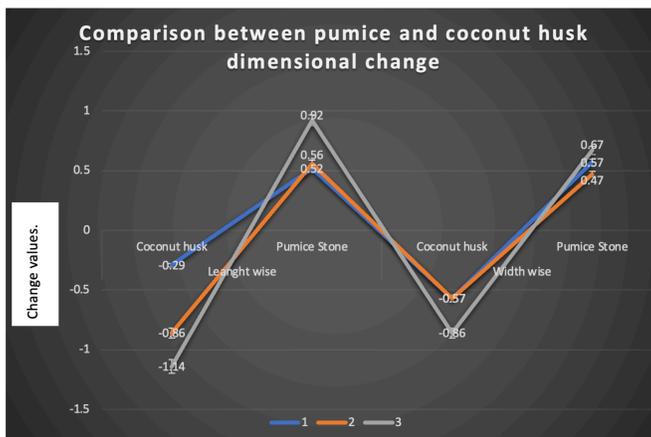


Fig 4. Shrinkage test results analysis for coconut enzyme denim wash with pumice stone enzyme denim wash

The Figure 4 illustrates this clearly. When compared with stone washing, coconut husk have a very high-quality impact on denim washing. Accordingly, pumice stone denim wash dimensionally changes by 0.52%, 0.56%, and 0.92% when compared to coconut husk denim wash, giving us a positive result of respectively -0.29%, -0.86, and -1.14. There is a little bit more change in the third garment sample due to the fabric structure. Pumice stone shows a widthwise dimensional change of 0.57%, 0.47% and 0.67% while coconut husk shows a dimensional change of -0.57%, -0.57% and -0.86% respectively. Therefore, it will demonstrate that coconut husk can effectively replace stone in the process of washing denim.

### 3.3 GSM test

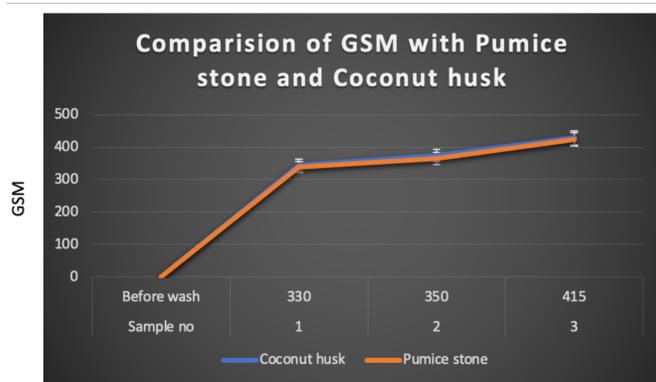


Fig 5. Comparison of the GSM variation among three types of denim fabric

From Figure 5, we can examine that the GSM of three kinds of fabric extended in accordance with the material type. Since the warp yarn is subjected to significant energy at some point of weaving and, after relaxation, it reduces in each direction, the washing process influences the GSM. GSM of the three types of washed samples multiplied by using nearly 3–7% in contrast to uncooked denim. The remaining output of increasing the GSM is like stone enzymes washing denim fabric. So, it proves that the coconut husk can substitute the stone in production.

### 3.4 Colour fastness to rubbing, washing, water

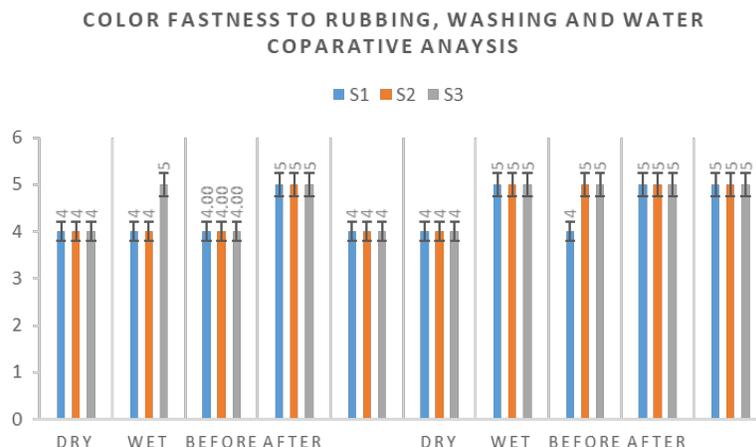


Fig 6. Color fastness to Rubbing, Washing and water results summery

As proven in determine 4, the ISO well-known grey scale has been used to visually determine the shade fastness of rubbing in dry and moist conditions, washing, and water testing. The colour fastness scale consists of 9 pairs of gray-colored chips, ranging from grades 1–5 (with 4 1/2 steps). Grade 5 represents no change, and Grade 1 depicts a severe exchange in some standard.

### 3.5 Colour fastness to perspiration

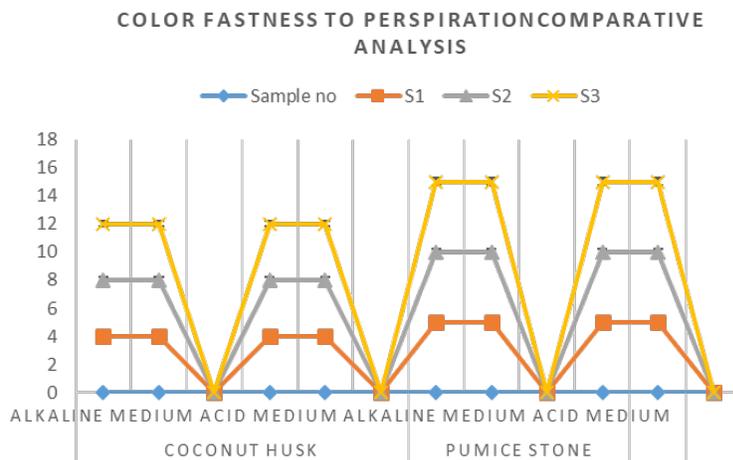


Fig 7. Color Fastness to perspiration test analysis

A color fastness to perspiration rating of 1–5 has been set in Figure 7 in accordance with the ISO world-known scale. On this scale, a 1 rating represents a very wide change. A rating of two indicates that there was a partial change. But a 4-5 rating shows no change. In the pumice stone treatment, the rating was 4-5 compared to better results in coconut husk. So, it proves coconut husk passes the perspiration test.

It is clear from Figure 8 (Production View) above that there aren't many differences between the three different sorts of samples. Experts in garment washing claim that a new fading wash design made from coconut husk can draw in more foreign buyers if they want to guarantee the viability of the garment washing industries. Future sustainable issues in these sectors of Bangladesh will be maintained by the result (Wash effect) of the denim fabric with coconut husk. In the opinion of garment

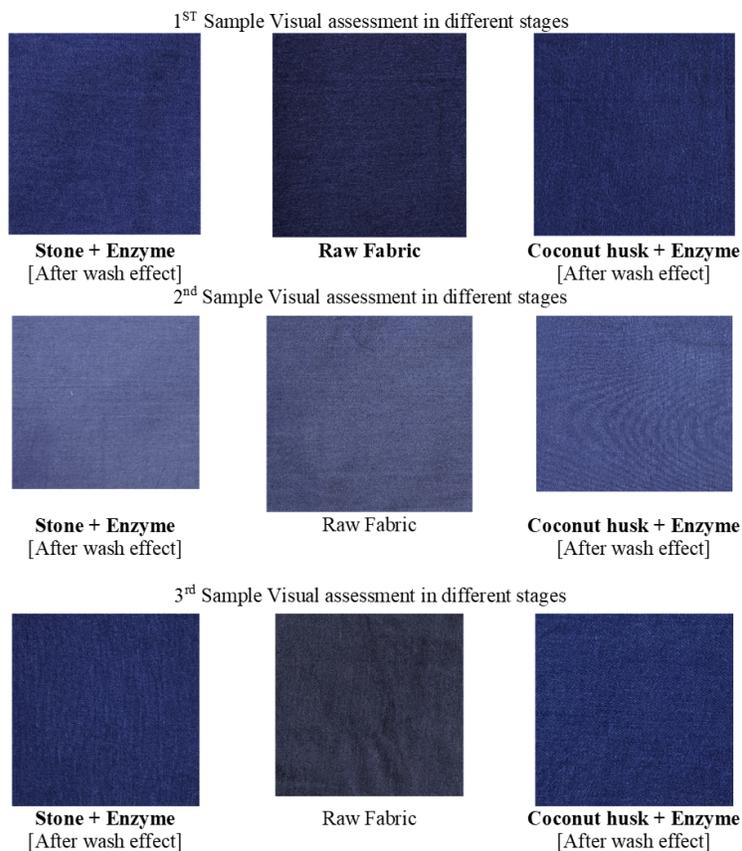


Fig 8. Visual Assessment of three types of washed denim fabrics

washing experts, coconut husk wash achieved a washing effect like pumice stone wash by 60–70%. Coconut husk can sometimes be used to create a new wash look from fashionable designs.

### 3.6 Tear strength test

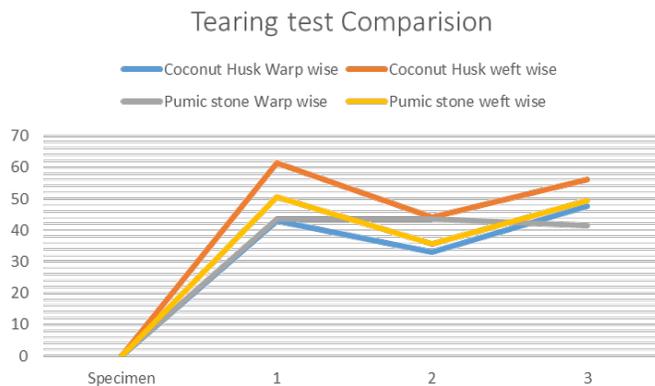


Fig 9. Tearing test analysis between pumice stone and Coconut husk denim wash

Figure 9 shows the tear strength of three different washed samples using the identical washing techniques in the warp and weft directions. Here, unwashed raw denim has greater tear resistance in both directions than comparable materials. In a perfect

world, the tear strength of enzymes and coconut husk wash is close to 47.61 N, and it gradually decreases to close to 32.94 N in the warp. On the other hand, the maximum average forces in the weft direction are 61.26 N, and they gradually decrease to 44.26 N. Conversely, the pumice stone has a lower value of 41.56 N and a higher value of 43.46 N, which is consistent with the coconut husk wash. This result also matched with stone and enzymes for denim washing, demonstrating how well coconut husk may replace stone.

### 3.7 Tensile strength test

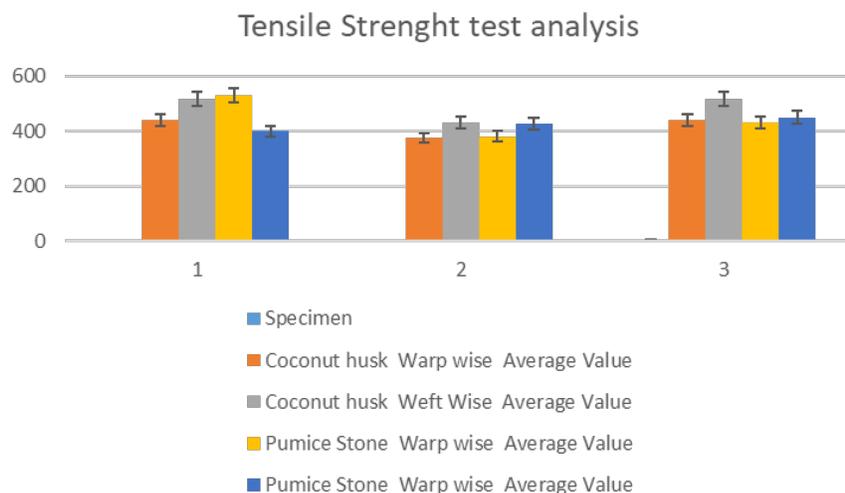


Fig 10. Tensile strength test analysis

Figure 10 displays the tensile strength of both the original and washed fabric samples. The force needed to make a specimen respond to stress is measured by a tensile test. The ruptured force, or tensile strength, is inversely proportional to the cross-sectional area<sup>(15)</sup>. The cloth in this outcome, which is washed by coconut husk as opposed to stone, generates additional force to elongate aside from enzyme wash. Coconut husk, on the other hand, has a Maximum of 440.39 N in the warp direction. With the action of stone on cellulosic materials, fibers are lost. Due to the enzymatic action on the cellulosic fibers in the enzyme wash, it occurred in the reverse way. In the weft direction, however, a presidential value of 518.24 N is discovered.

### 4 Conclusion

In recent years, garment washing has become one of Bangladesh’s most popular industries. Customers are becoming more fashion-conscious. These factors are contributing to the buyer’s use of the design and wash effect. Despite this, cost and pricing are the most important factors that affect the cost of production of garments. This study therefore offers a guarantee that Bangladesh’s garment-washing industry will remain viable for a long period of time. In addition to having similar fabric properties to stone wash, coconut husk also has the advantage of reducing harmful environmental effects. By using alternative to stone-washed denim, it produces results that are faultless without sacrificing their fashionable appearance. It was discovered by a wash technician that another color would draw in additional customers. We can infer that coconut husk would work well for washing. Because of the price of the stone, the producer is unable to lower the fixed cost of the wash in Bangladesh. In this study, the researcher used three types of denim fabrics to conduct these experiments. The ultimate output of this study shows similar results with coconut husk compared to pumice stone denim garment wash. The wash technician from the garment washing factory ensures that coconut husk can provide us with a 70% better effect than pumice stone with a lower M: L ratio. The pure indigo and indigo fabric represent minimum 70-80% shade match with traditional pumice stone denim washing where grey fabric shows only 30-40% shade match because of (sulfur (S) topping. The results can be 100% Achieved by using more chemicals on the traditional recipe. In the future, more fabric types can be tested for better output.

## 5 Acknowledgement

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