

# Investigation of the Physico-Mechanical Properties of Different Portions of Tossa and White Jute Fibre

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## Abstract

This research work investigates to select the appropriate portion like top, middle, bottom for both Tossa and White jute for suitable applications such as reinforcement, blending yarn, and diversified jute products. The fundamental properties of Tossa and White such as bundle strength, fineness, breaking twist, and whiteness (%) were studied. It was observed that the maximum strength found at the bottom portion for both Tossa and White were 10.35 lbs/mg, 10.08 lbs/mg respectively. The results revealed the higher breaking twist and whiteness (%) at the middle portion for both Tossa and White jute were 42.65, 36.75, 42.5%, 39% respectively. The better fineness found that at the top portion of Tossa and White jute were 36.15, 31.05 respectively.

**Keywords:** Physico-Mechanical, Tossa, White Jute Fibre.

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## INTRODUCTION

Due to the green movement in the world, many researchers have focused the natural fibers as replacements for synthetic fibers which create the demand for natural fibers and is also important to find the appropriate properties of natural fibers (Dayan *et al.*, 2020; Ganapathy *et al.*, 2019). The demand for natural fibers is increasing day by day due to their eco-friendly and renewable nature (Thyavihalli Girijappa *et al.*, 2019). The jute fibers are used in high-grade composite due to their environmental sustainability and biodegradability (Ganapathy *et al.*, 2019). Jute is a lignocellulosic fibrous crop that belongs to the genus *Corchorus* of the *Tiliaceae* family with two cultivated species namely, *Corchorus olitorius* L. (Tossa jute) and *Corchorus capsularis* L. (White jute) (Kundu *et al.*, 2013). The properties of the two species are varied because Tossa jute mainly grows on high land compared to White jute in Bangladesh (Mollah *et al.* 2021).

The main chemical compositions of jute fiber are cellulose, hemicellulose, and lignin which affect the physico-mechanical properties (Kaysar & Uddin, 2020; Ronald Aseer *et al.*, 2013). The tensile strength is also

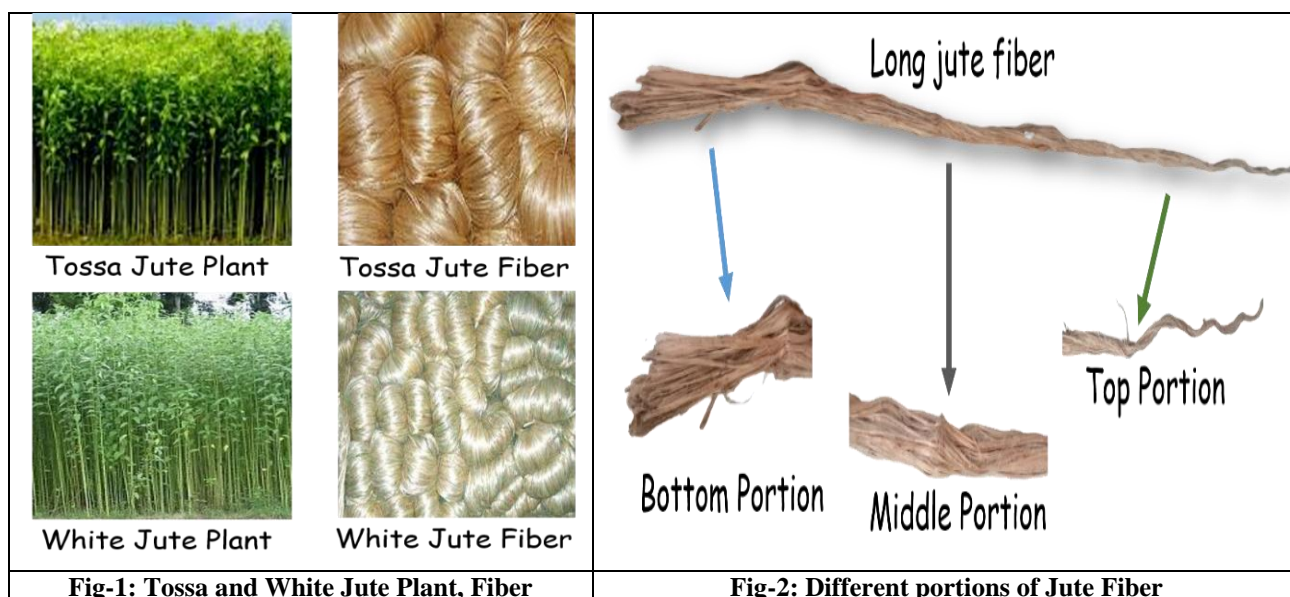
influenced by the fiber diameter of jute fibers (Duval *et al.*, 2011; Marrot *et al.*, 2013). The physico-mechanical properties of jute fibers are changed by different factors such as changes in climate, geographical place, retting, soil fertility, fertilizer application, plant variety, and harvesting time (Babu *et al.*, 2020; Juradin *et al.*, 2019). Jute fibers from bottom to top portion have different such as fiber bundle strength, fineness, fiber breaking twist, whiteness (%), etc. The physico-mechanical properties of jute fibers vary greatly, rendering them unsuitable for use in high-grade composite materials and diversified jute products where high reliability and stability are required. The physico-mechanical properties of jute fiber are essential for composite fabrication and development the industrial products. In the present study, fiber bundle strength, fineness, fiber breaking twist, whiteness (%) were characterized by Pressley fiber strength tester, Digital fiber fineness analysis system, Breaking twist tester, and Photo-volt meter. Subsequently, different portions of Tossa jute and White jute were evaluated and classified in their performance.

## MATERIALS AND METHODS

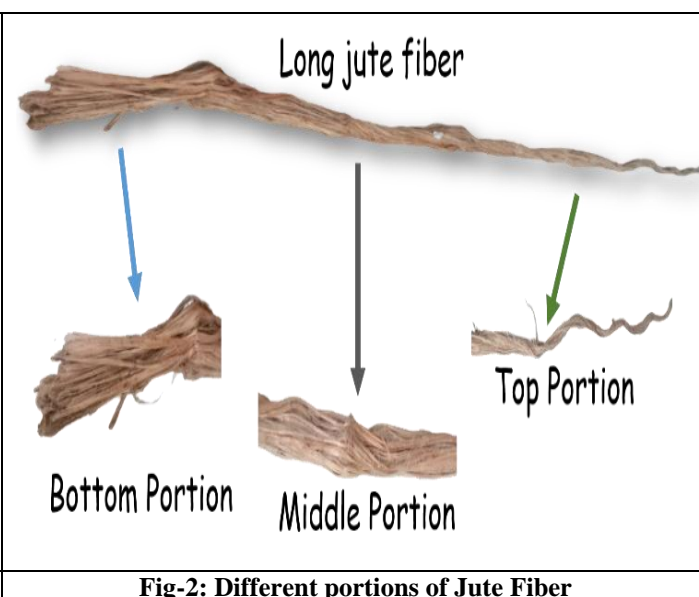
Jute fibers of Tossa and White of 100 days harvesting were collected from Bangladesh Jute

Research Institute which are shown in Fig.1. All the samples were cut manually into three portions like as bottom, middle, and top (Fig.2). These jute fibers were thoroughly combed before bundle strength, breaking

twist and fineness. Four parameters of jute fibers Bundle Strength, Fineness, Breaking Twist, Whiteness (%), were characterized in the textile physics division, Bangladesh Jute Research Institute.



**Fig-1: Tossa and White Jute Plant, Fiber**



**Fig-2: Different portions of Jute Fiber**

**Bundle fiber strength tester**

Pressley strength tester is used to determine the bundle of fiber strength of textile raw materials. It includes clamps (distance from 0" to 1/8" can be chosen). Use of Pressley requires a torsion balance up to 5 mg and 0,01 mg accuracy (code 259D). Bundle strength (Presley index ASTM D-1445) of fibers was determined by Presley Fiber Strength Tester (Using zero-gauge length). The flat bundle of fibers of approx. 6.35mm (1/4 inch) width was held by a pair of clamps. All Protruding ends were then shear off and tension was applied to separate the clamps and thereby break the fibers. The broken bundle fiber was then weighed in a precision balance. The resulting strength was then computed by the relation as expressed below.

$$\text{Pressley Index} = \frac{\text{Breaking Load (lbs)}}{\text{Bundle Weight (mg)}}$$

**Fineness test**

Fiber Fineness is another important property of jute fiber. Jute fiber fineness was measured ISO-137 used YGOO2C Fiber Fineness Analysis System by Panasonic WV-CP310/CH, location at Textile Physics Division BJRI. "Measure Diameter Automatically" is a new method of fiber diameter measurement. It measures all valid fibers within a field, no longer needs to select each fiber by the cursor. But it does require a finely made fiber-fragment sample, otherwise, too few fibers can be measured to get a certain statistical result, so work with this method carefully.

**Breaking twist tester**

Jute fiber has a meshy network. Jute fibers taken from the top, middle, and bottom portion of jute

reeds were combed by a hand-operated combing machine to break the mesh and sort out single fibres. At first, the twist tester counter set zero. A single fiber sorted out for measuring breaking twist was gripped between the rotating and non-rotating jaws of the hand-driven twist tester machine. The test sample gauge length was one inch. Then twist was applied to the fiber until it broke and the number of twists needed to break the fiber was recorded from the counter. The same procedure was applied to other fibers for measuring breaking twist. For the study, 20 readings of each Tossa and White (Top, Middle, and Bottom) were taken.

**Whiteness (%) measurement**

Whiteness (%) was measured in percentage compared with the whiteness percentage of MgO which is considered as hundred percent white by using PHOTOVOLT PERCENTAGE REFLECTANCE METER Model 577, USA.

**RESULTS AND DISCUSSION**

The bundle strength (lbs/mg) of Tossa fibers of different portion from bottom to top portion are found 10.35 lbs/mg, 10.25 lbs/mg, 9.6 lbs/mg respectively. On the other hand, bundle strenght of bottom, middle and top portion of White jute fiber are found 10.08 lbs/mg, 9.85 lbs/mg, 9.54 lbs/mg respectively. The results obtained that, Tossa and White jute fiber in the bottom portion were higher as compared to middle and top portion which are shown in Fig. 3.1 and Fig. 3.2. According to results, it was found that the bundle strength of Tossa and White jute fibers decreases lenthwise from bottom to top portion. The mechanical properties of cellulosic fiber are enhanced due to the higher crystallinity index and lower orientation angles

(Sekhar Das *et al.*, 2019). There are many factors like as fiber’s chemical composition, cell dimension, defects, structure, individual jute cell length, etc. affect the tensile properties of jute fibers (Sekhar Das *et al.*, 2019). The bundle fiber strength or tensile properties of jute fibers are directly influenced the composite materials (Hasan, 2013).

The results shown that, the fineness of Tossa jute fiber of different portions from bottom to top portion are 39.45µm, 38.40 µm, 36.15 µm respectively. But fineness of bottom, middle and top portion of White jute fiber are found 34.35 µm, 32.1 µm, 31.05 µm respectively. White jute fiber is finer than Tossa jute fiber. According to the results, it can be concluded that for both Tossa and White jute fibers, the top portion is finer compared to bottom and middle portion which are shown in Fig.4.1 and Fig. 4.2. The fineness of jute fibers for Tossa and White jute were found different according to the lengthwise from top to bottom portion due to the variation of the jute fibers maturity (Shahinur *et al.*, 2015).

The values for the breaking twist for both Tossa and White jute fiber of different portions bottom to top are presented in Fig. 5.1 and Fig. 5.2. The mean values of breaking twist for Tossa jute fiber are found

41.2, 42.65, 34.35 respectively and White jute fiber are 32.25, 36.75, 31.10 respectively. Test results indicate that, for both Tossa and White jute fibers of breaking twist in the middle portion is much better than top and bottom portion. In comparison to breaking twist of two varieties, Tossa jute is higher spinning quality yarn than White jute.

It was observed that the whiteness (%) of different portions from bottom to top for Tossa jute were 41.65%, 42.50%, 40.12% respectively and White jute fiber are 37.10%, 39%, 38.10% respectively.

Test results indicate that, Whiteness % of Tossa is lightly high compared to White jute fiber. But in case of three portion, middle portion of Tossa and White jute appeared to be better than that of other two portion. Whiteness (%) is one of criteria for assessment of the quality of fibers in industries, research and fiber grading system (Roy *et al.*, 2016). There are many factors such as black spot, specks, knot, diseases of plant etc. are prevented to reflect the light from the fibers surface for measuring the color (Ghosh *et al.*, 2013) and color is also depends on the water quality and retting process (Sujai Das *et al.*, 2013; G Roy *et al.*, 2017).

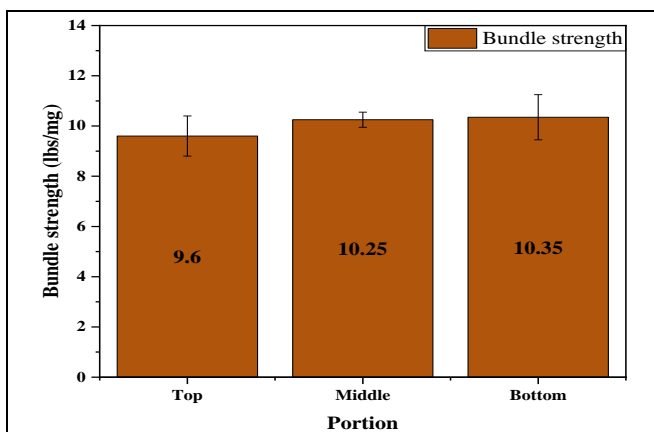


Fig-3.1: Bundle Strength of Tossa Jute

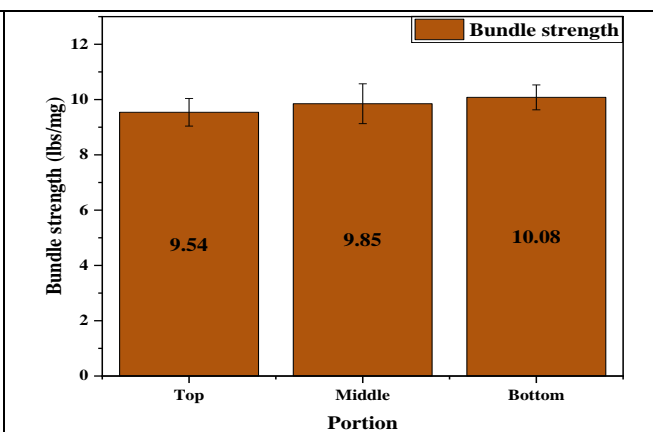


Fig-3.2: Bundle Strength of White Jute

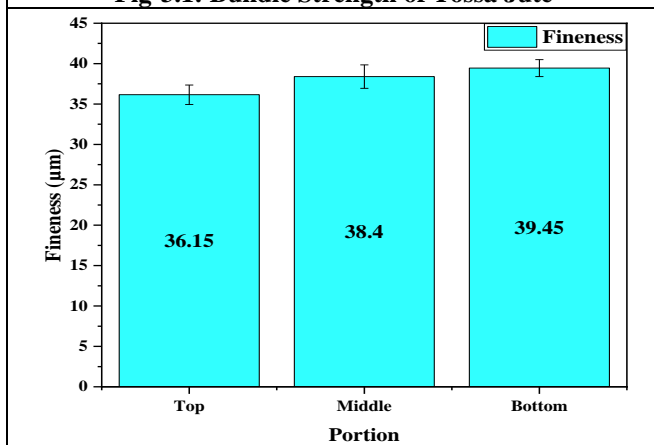


Fig-4.1: Fineness of Tossa Jute

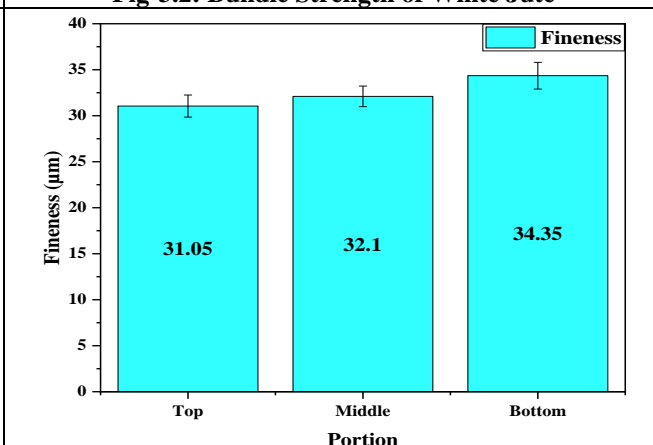


Fig-4.2: Fineness of White Jute

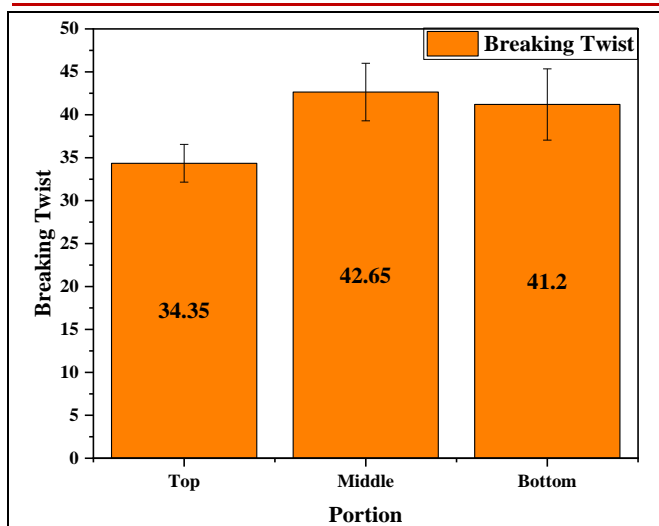


Fig-5.1: Breaking Twist of Tossa Jute

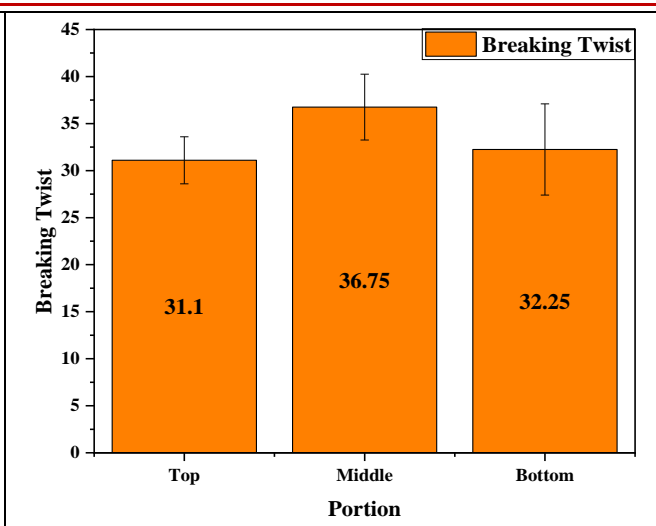


Fig-5.2: Breaking Twist of White Jute

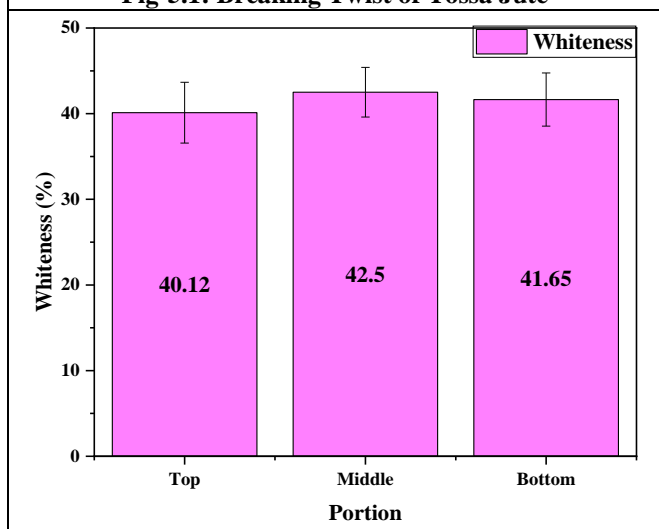


Fig-6.1: Whiteness of Tossa Jute

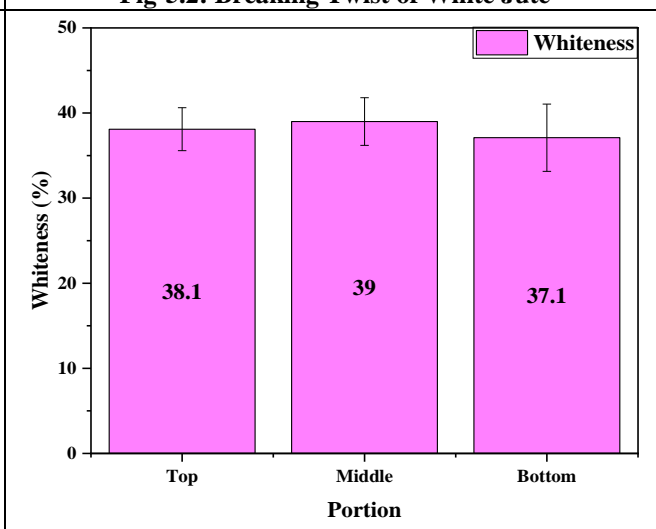


Fig-6.2: Whiteness of White Jute

## CONCLUSION

The present investigation has emphasized the physico-mechanical properties of different portions for Tossa and White jute fiber. It can be concluded that, the bundle fiber strength (lbs/mg) has found better in the bottom portion compared to other two portions for both varieties. On the hand, fineness (micrometer) has improved along the length from bottom to top portion for both varieties. The middle portion of Tossa and White jute fiber had higher whiteness (%) as compared to the other two portions and Tossa also had better whiteness (%) compared to white jute fiber. In comparison to breaking twist of two varieties, Tossa jute is higher spinning quality yarn than White jute. Tossa jute fiber is suitable for composite fabrication because of higher strength compared to White jute fiber.

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