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Regional variation of cotton linter fibers

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Abstract

This work presents the effect of regional variation (Varamin-Tehran, Klibar-Azarbayjan & Nishabor-Khorasan) on the biometry properties of cotton linter fibers in Iran. Results of analysis of variance (ANOVA) indicated that the region had significant effect on the biometry properties of cotton linter fibers. The highest and lowest of fiber length and slenderness ratio were found in Tehran and Khorasan site, respectively. The values of fiber width, cell wall thickness and Runkel ratio in Azarbayjan region and fiber lumen diameter and flexibility ratio in the Khorasan site is more than other regions. The mean of fiber length, fiber width, cell wall thickness and lumen diameter were determined 2860, 19.96, 9.28 and 10.68 µm for combined regions in Iran.

Keywords: Cotton linter, Fiber properties, region, Iran.

Introduction

Cotton is a shrub native to tropical and subtropical regions around the world, including the China, India, United States, Pakistan, Brazil, Uzbekistan, Australia, Turkey, Turkmenistan and Greece (National cotton council of America-Ranking). Current estimates for world production are about 25 million tons annually, accounting for 2.5% of the world's arable land. China is the world's largest producer of cotton, but most of this is used domestically. The United States has been the largest exporter for many years.

Cotton is used to make a number of textile products. These include terrycloth for highly absorbent bath towels and robes; denim for blue jeans; chambray, popularly used in the manufacture of blue work shirts; and corduroy, seersucker, and cotton twill, Socks, underwear, most T-shirts are made from cotton. Bed sheets often are made from cotton. Cotton also is used to make yarn used in crochet and knitting. While many fabrics are made completely of cotton, some materials blend cotton with other fibers, including rayon and synthetic fibers such as polyester. In addition to the textile industry, cotton is used in fishing nets, gunpowder, cotton paper, and in bookbinding. The first Chinese paper was made of cotton fiber (Liese M Perrin, 2001). The name Egyptian cotton is broadly associated with quality products, however only a small percentage of Egyptian cotton production in actually of superior quality. A temperature range of 25 ^{0}C to 35 ^{0}C is the optimal range for mold development at temperatures below ^{0}C, rotting of wet cotton stops (http://www.Cottonguide.org/chapter-5/extra-long-staple-cotton). The aim of this research is the investigation of biometry of linter cotton in three regions in Iran to determining potential of cotton fiber as a raw material in lingo-cellulosic industry.

Materials and methods

Cotton linter fibers were selected from three regions such as Varamin-Tehran, Klibar-Azarbayjan and Nishabor-Khorasan in Iran. These fibers separated with Franklin methods and then the fiber length, fiber diameter, and lumen width were measured with a microscope equipped with a Leica Image Analysis System (Quantimeta 100+). The fiber wall thickness was calculated as a difference of fiber diameter and lumen width divided in half. For dimensions of 30 fibers were randomly measured. From these data, the average fiber dimensions were calculated and then the following derived indexes were determined:

Runkel ratio= 2 × (Wall thickness/Lumen width)

Flexibility ratio=(Lumen width of fiber/Diameter of fiber)×100

Slenderness ratio= (Length of fiber/Diameter of fiber)

Results

Fiber dimensions

The fiber dimensions are among the most important indices for selecting a lignocellulosic fiber for pulp and paper making. The descriptive statistics for fiber dimensions of cotton linter in three regions are shown in Table.1. The analysis of variance (ANOVA) indicated that the region had significant difference on the fiber length of cotton linter. The highest and lowest of fiber length were found in Tehran and Azarbayjan regions, respectively. The fiber length values in Tehran region are taller than 10 and 12% of fiber length in Khorasan and Azarbayjan regions, respectively. The mean fiber length was 2.86 mm in combined regions.

Table 1. Descriptive statistics for fiber dimension of cotton linter

Region	Fiber length	Fiber width	Two-cell wall thickness	Lumen diameter
Khorasan	2.79 (23.6) b	19.99 (15.5) a	8.89 (25.5) b	11.11 (25.6) a
Azarbayjan	2.74 (22.9) b	20.51 (12.3) a	9.74 (18.2) a	10.86 (23.3) a
Tehran	3.07 (20.3) a	19.38 (12.1) b	9.23 (20.1) b	10.34 (22.2) b
F	15.389 **	8.902 **	9.430 **	7.192 **

** *Significant at 0.01*

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The analysis of variance (ANOVA) showed that there are significant differences between region and fiber diameter of cotton Linter. The highest and lowest of fiber diameter were found in Azarbayjan (20.51 µm) and Tehran region (19.38 µm), respectively. The mean fiber diameter in Azarbayjan region is higher than 2.60 and 5.83% of fiber diameter in Khorasan and Tehran sites, respectively. The mean fiber diameter of Cotton Linter fibers were 19.96 µm in combined regions.

The analysis of variance (ANOVA) showed that there are significant differences between region and cell wall thickness of Cotton Linter. The mean cell wall thickness were 8.89, 9.74, and 9, 23 µm for Khorasan, Azarbayjan and Tehran sites, respectively. The cell wall thickness in Azabayjan site is higher, which is higher than 5 and 9% of cell wall thickness in Tehran and Khorasan region. The mean cell wall thickness was 9.28 % in the combined regions.

The analysis of variance showed that there are significant differences between region and lumen diameter of Cotton Linter. The mean lumen diameter was 11.11, 10.86, and 10.34 µm, respectively. The lumen diameter in Khorasan region is higher than of lumen diameter in Azarbayjan (2.30%) and Tehran (7.30%) regions. The average of lumen diameter of Cotton Linter was 10.68 µm in combined regions.

Table 2. Descriptive statistics for morphological features of cotton linter

Regions	Slenderness ratio	Flexibility ratio	Runkel ratio
Khorasan	139.5 (27) b	55.33 (17.8) a	80.02 (44) b
Azarbayjan	133.98 (23.3) c	52.9 (15.9) b	89.69 (37.2) a
Tehran	158.62 (22.2) a	53.3 (16.8) b	89.26 (39.6) a
F	28.259**	8.008 **	6.139**

*** Significant at 0.01*

Morphological properties

The descriptive statistics for morphological features of Cotton linter in three regions are shown in Table.2. The analysis of variance (ANOVA) indicated that there are significant differences between region and morphological feature. The highest and lowest of slenderness ratio were found in Tehran and Azarbayjan regions. The flexibility ratio of cotton linter in Khorasan region and Runkel ratio in Azabayjan region is higher than other region.

Discussion

When the slenderness ratio is higher, the quality of the manufacture paper would be better. Generally, the acceptable value for slenderness ratio of papermaking fibers is more than 33 (Akgul & Tozluoglu, 2009) which these features were found in three studied regions. These values varied between regions from 133.98 to 158.62.

According to the flexibility ratio, there are 4 groups of fibers: 1- high elastic fibers having elasticity coefficient greater than 75. 2- Elastic fibers having elasticity ratio between "50-75". 3- Rigid fibers having elasticity ratio between "30-50". 4- High rigid fibers having elasticity ratio less than 30 (Akgul & Tozluoglu, 2009). According to this, flexibility coefficient in Azarbayjan, Khorasan and Tehran regions are 52.59, 55.35, and 53.33%, respectively. Thus, they can be considered as elastic fibers group.

When Runkle proportion is greater than 1, it is assessed as fiber having thick wall and cellulose obtained from this type fibers is least suitable for paper production; when it is equal to 1, cell wall have medium thickness and cellulose obtained from this type fiber is suitable for paper production, when the rate is less than 1, cell wall is thin and cellulose obtained from these fibers is most suitable for production of paper (Akgul & Tozluoglu, 2009). According to this, Runkle value in three regions is less than 1 and it is classification in thin cell wall fibers group.

Conclusions

In this study, the fiber properties and biometry features of cotton linter fibers in three sites were investigated. The linter cotton fibers in three sites (regions) are suitable for pulp and papermaking due to good fiber length and biometric features.

Reference

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