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QUALITY INDICATORS OF COTTON FIBER ANALYZED

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Abstract: The article presents the results of the laboratory analysis of the cotton fiber of the Andijon 36 cotton variety produced at the Torakorgan cotton ginning plant before sawing and the fiber extracted after sawing, and the conclusions of the HVI 900 system.

Keywords: fiber, HVI 900, seed, lint, working chamber, ribs, saw, gin machine, raw material roller, shaft.

Introduction. In cotton processing enterprises, the main product is fiber, which is considered a crucial factor for spinning production. One of the most significant issues in the initial processing of cotton at cotton ginning plants that are part of textile clusters is fiber damage caused by the mechanical impact and frictional forces exerted on the raw cotton. In our country, substantial work is being carried out to eliminate these issues, and researchers are conducting scientific studies. However, these efforts are not yet sufficient. [1]

Taking these aspects into account, this article investigates the changes in fiber quality before and after ginning. The study presents several characteristics of fiber output quality before and after ginning using a 4DP 130 type saw gin.

Laboratory analysis of fiber quality indicators is currently carried out using modern equipment. The HVI (High Volume Instrument) system developed by the Uster company is rapidly advancing in determining cotton fiber quality characteristics. [2]

The implementation of this system enables high-accuracy and rapid analysis of cotton fiber quality indicators. While the HVI system was initially used in cotton processing enterprises and quality assessment centers, today it is widely applied in textile industry enterprises as well.

Methodology & empirical analysis. The HVI system allows the determination of the following fiber properties:

- **Micronaire (mic)** – determined based on the air permeability of the cotton fiber sample, indicating the fineness and maturity of the fiber. The acceptable range for Grade I and II cotton fibers is 3.5–4.9. 52% of Uzbek cotton fibers fall within this range.
- **Upper Half Mean Length (UHM)** – the average length of the longest fibers that constitute half the mass of the tested sample, measured in inches.

• **Staple length** – the actual length of the fiber.

• **Uniformity index** – measured as the ratio of the average fiber length to the longest fiber length. The uniformity index should be above 80%. The uniformity index of Uzbek cotton is 83.3%.

In addition, the HVI system analyzes indicators such as the short fiber index, reflectance (Rd), yellowness (+b), trash code, specific breaking strength, and elongation at break. [3]

One of the shortcomings of Uzbek cotton in terms of micronaire is that, despite falling within the accepted range of 3.5–4.9, newly developed and introduced cotton varieties tend to have higher average micronaire values (around 4.6–4.7). In contrast, foreign breeders aim to develop varieties for irrigated fields with an optimal average micronaire value of 4.3, and medium-staple cotton varieties classified under types 3–4 in terms of fiber length. [4]

According to O‘zDST 614, the samples selected for measurement should have a moisture content ranging from 6.75% to 8.25%. Prior to measurement using the HVI system, samples must be conditioned to the required moisture level using a fast conditioning device or stored under standard climatic conditions for 24 hours. [5]

To conduct measurements using the HVI 1000 system, the sample mass should be (10 ± 1.5) grams. If the micronaire value is below 2.0 or above 7.0, the monitor displays the message “Undesirable Micronaire.” In such cases, the measurement must be repeated.

Experiments were conducted using the HVI system to analyze fiber length, length uniformity, strength, elongation at break, fineness and maturity, color, and trash content of cotton fibers. The experiments were conducted at the "Turakurgan Cotton Ginning Plant" under "Namangan Textile Cluster" LLC, using the Andijan-36 variety. Based on the results, the following tables were compiled. [6,7]

Results. From Table 1, it was observed that among the samples taken before ginning using the 4DP-130 type saw gin, the Micronaire (Mic) value reached its highest measurement during the fifth test, recording 4.7, while the lowest value was observed in the third test, with a result of 4.5. [8,9].

Table 1. Pre-ginning fiber samples (from saw gin input)

№	Mic	Str	Len	Unf	SFI	Elg	Cnt	Area	CG	Rd	+b
1	4,6	32,6	1,21	84,1	<3,5	7,0	29	0,9	31-1	76,8	8,5
2	4,6	34,1	1,20	87,0	<3,5	6,2	22	0,7	31-2	75,9	8,5
3	4,5	34,1	1,19	85,4	<3,5	6,0	27	0,9	31-1	77,1	8,5
4	4,6	30,7	1,18	85,8	<3,5	5,8	26	0,9	31-3	77,0	8,7
5	4,7	29,3	1,18	84,5	5,0	7,0	28	0,8	41-3	75,9	8,8
6	4,5	31,6	1,17	84,4	4,1	6,4	34	1,2	31-1	73,8	8,7
7	4,5	33,9	1,20	85,2	<3,5	5,9	12	0,4	31-1	76,9	8,4
8	4,6	34,4	1,19	86,4	4,0	5,8	8	0,3	31-1	77,0	8,3
9	4,5	30,9	1,18	86,1	4,4	6,0	23	0,7	31-4	75,9	8,6

Regarding specific breaking strength (Str), among the nine tested samples, the eighth measurement showed the highest value of 34.4 gc/tex (HVI Calibration Cotton), while the lowest value was recorded during the fifth test, at 29.3 gc/tex.

In terms of Upper Half Mean Length (Len), the lowest fiber length was observed during the sixth test, with a result of 1.17 inches, and the highest value was obtained during the first test, at 1.21 inches.

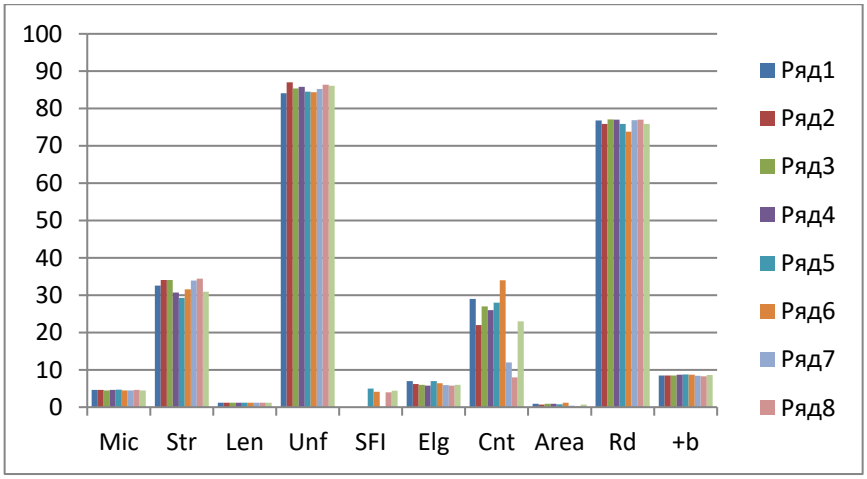

Figure 1. Graphical indicators of results obtained before saw ginning

The Uniformity Index (Unf) reached its lowest value of 84.1% in the first test, while the highest value, 87%, was recorded during the second test.

The Short Fiber Index (SFI) showed its highest value of 5% in the fifth test, whereas the lowest value, 3.5%, was observed in both the first and fourth tests, indicating consistent results in these trials.

Regarding Elongation at Break (Elg), the maximum value of 7.0% was observed in both the first and fifth tests, while the minimum value, 5.8%, was recorded during the fourth and eighth tests. [10,11]

The Trash Count (Cnt) was lowest in the first test, with only eight trash particles detected, whereas the highest count, thirty-four, was observed during the sixth test. [12]

Table 2

№	Measurement indicator and unit	Measurement	Maximum allowable systematic error	Maximum root mean square deviation (RMSD)
1	Micronaire (Mic)	4,6	0,07	1,55
2	Specific Breaking Strength (Str)	32,4	1,85	5,72
3	Upper Half Mean Length (Len)	1,19	0,01	1,07
4	Length Uniformity Index (Unf)	85,4	0,98	1,15
5	Short Fiber Index (SFI)	3,5	0,96	27,52
6	Elongation at Break (Elg)	6,2	0,47	7,61
7	Trash Particle Count (Cnt)	23	8,32	35,82

8	Trash Area (Area)	0,8	0,27	36,31
9	Color Grade (CG)	31-2	41-3	31-1
9	Reflectance Degree (Rd)	76,3	1,06	1,39

The highest Trash Area (Area) value of 1.2% was observed during the sixth trial, while the lowest value of 0.3% was recorded in the eighth trial.

The highest Color Grade (CG) value, 41-3, was confirmed during the fifth trial. In contrast, the lowest CG value, 31-1, was consistently observed in the first, third, sixth, seventh, and eighth trials.

The Reflectance Degree (Rd), which indicates the amount of light reflected from the surface of the cotton fiber sample, reached its maximum value of 77.1 in the third trial. The minimum reflectance observed was 73.8.

Regarding the Yellowness Index (+b), the lowest value of 8.3 was recorded during the eighth trial, while the highest value of 8.8 was obtained in the fifth trial.

Based on the data presented in Table 1, average values for each indicator were calculated, and the results are summarized in Table 2. [13]

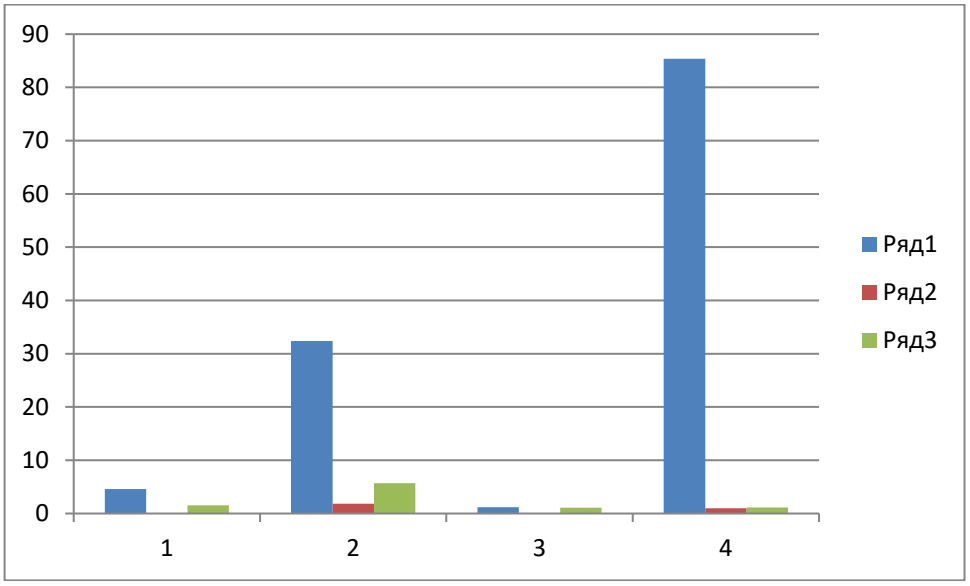

Figure 2. Graphical representation of the results obtained before ginning with the 4DP-130 saw gin

Based on Table 2, the average values were calculated from the fiber quality parameters of cotton that had been hand-separated from the seed before ginning with the 4DP-130 saw gin. These cotton samples were tested nine times using the HVI (High Volume Instrument) system, and the results are presented in Table 1.

Table 3.

№	Mic	Str	Len	Unf	SFI	Elg	Cnt	Area	CG	Rd	+b
1	4,5	32,0	1,13	85,6	4,5	6,7	22	0,2	31-1	77,7	8,8
2	4,5	32,2	1,13	84,6	6,4	6,1	11	0,1	31-1	77,6	8,6
3	4,6	32,6	1,17	84,6	6,8	6,5	16	0,2	31-4	74,5	9,2
4	4,5	31,7	1,16	84,1	5,4	6,0	16	0,2	31-3	75,1	9,2
5	4,4	32,2	1,14	85,5	6,0	6,1	15	0,1	31-4	75,4	9,0
6	4,5	28,3	1,13	85,1	6,6	6,3	16	0,2	31-4	75,2	8,8
7	4,5	33,9	1,15	83,9	6,8	6,8	18	0,2	31-4	76,1	8,6
8	4,5	28,8	1,12	84,1	7,7	5,9	8	0,1	21-4	78,1	9,1
9	4,5	34,4	1,16	84,5	5,3	6,9	9	0,1	21-4	77,9	9,1

Similarly, the fiber quality indicators of the Andijan-36 cotton variety, separated from the seed using the 4DP-130 saw gin, were also analyzed using the HVI system. In this case, the fiber was again separated manually from the seed, tested nine times, and the results are summarized in Table 3. [14]

The fiber quality indicators of the cotton processed through the 4DP-130 saw gin were also analyzed using the HVI system. The Micronaire (Mic) value, which characterizes the fineness and maturity of the fiber, reached its highest value of 4.6 in the third trial, while the lowest value of 4.4 was recorded during the fifth trial.

The Specific Breaking Strength (Str), indicating the fiber's tenacity or resistance to breakage, showed the highest result of 34.4 g/tex in the ninth trial. The lowest strength value of 28.8 g/tex was observed in the eighth trial.

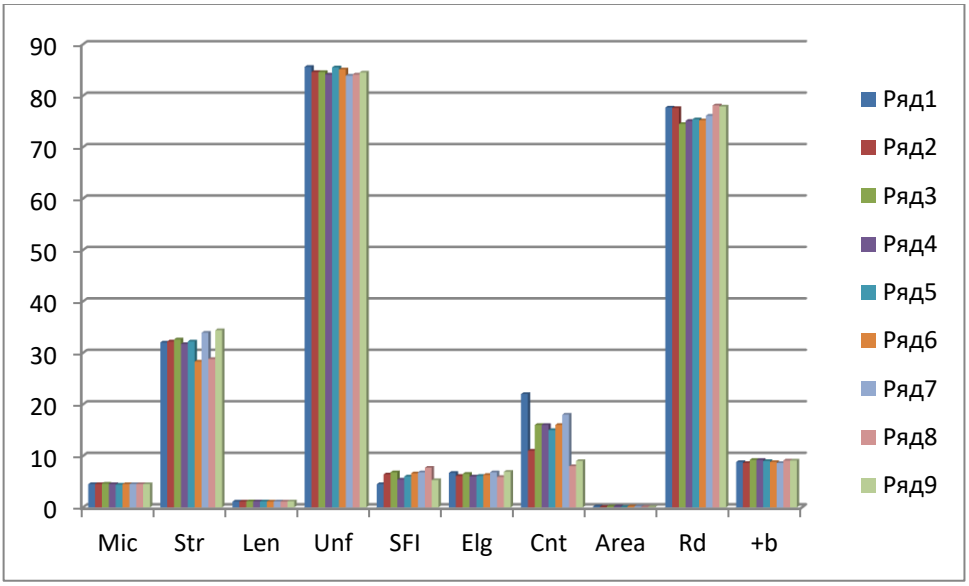

Figure 3. Graphical representation of the results obtained from the fiber processed through the saw gin

The Upper Half Mean Length (Len) was found to be 1.12 inches in the eighth trial, while the highest value of 1.17 inches was recorded in the third trial. The Length

Uniformity Index (Unf) ranged from a maximum of 85.6% to a minimum of 83.9%. The Short Fiber Index (SFI) showed a maximum value of 7.7 mm, while the minimum was 4.5 mm.

According to the readings from the dynamometer in the instrumental system, the Elongation at Break (Elg) ranged from 5.9% (lowest) to 7.9% (highest). The Trash Particle Count (Cnt) varied between 8 and 30 particles, and the Trash Area (Area) ranged from 0.1% to 0.2%. The Color Grade (CG) showed a lowest grade of 21-4 and a highest of 31-4.

Table 4.

№	Measurement indicator and unit	Measure ment	Maximum allowable systematic error	Maximum root mean square deviation (RMSD)
1	Micronaire (Mic)	4,5	0,05	1,11
2	Specific Breaking Strength (Str)	31,8	2,04	6,43
3	Upper Half Mean Length (Len)	1,14	0,02	1,52
4	Length Uniformity Index (Unf)	84,7	0,61	0,73
5	Short Fiber Index (SFI)	6,2	0,97	15,74
6	Elongation at Break (Elg)	6,4	0,37	5,82
7	Trash Particle Count (Cnt)	15	4,48	30,75
8	Trash Area (Area)	0,2	0,05	33,88
9	Color Grade (CG)	31-3	21-8	21-4
9	Reflectance Degree (Rd)	76,4	1,42	1,86
10	Micronaire (Mic)	8,9	0,24	2,68

The Reflectance Degree (Rd), indicating the amount of light reflected from the surface of the cotton fiber sample, was observed to be 78.1 at its highest and 74.5 at its lowest. The Yellowness Index (+b) ranged from a minimum of 8.6 to a maximum of 9.2. Based on the analysis of Table 3, the average values of the nine samples tested were calculated, and the results were compiled into Table 4 [15].

In Table 2, the average values of fiber quality indicators of cotton before ginning with the 4DP-130 saw gin were determined using the HVI system. Subsequently, in Table 4, the fiber quality indicators of cotton after being processed through the 4DP-130 saw gin were measured using the same HVI system.

By comparing the data from Tables 2 and 4, the impact of the ginning process using the 4DP-130 saw gin on the fiber quality was evaluated.

Based on this comparison, the graphical representations shown in Figures 1 and 2 were developed to visually illustrate the effect of the ginning process on fiber properties.

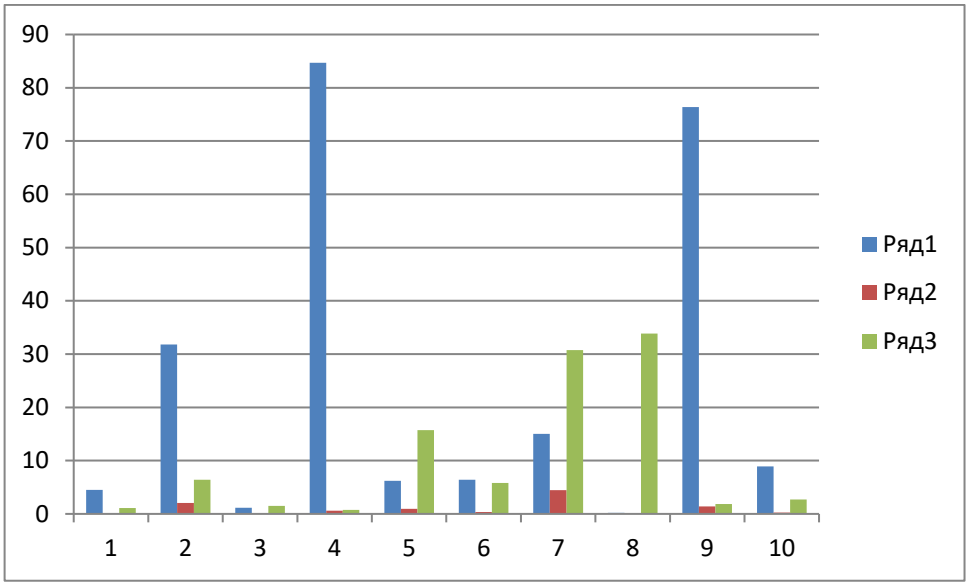

Figure 4. General graphical representation of the results obtained from the fiber processed through the saw gin

Conclusion. Based on the above analysis, the quality indicators of cotton fiber before and after ginning with the 4DP-130 saw gin were evaluated using the HVI 900 system. The results were compared against the requirements of the O‘zDST (Uzbek State Standards) and international standards.

The comparison, based on the data in the tables and graphical figures, revealed how the ginning process affects fiber quality. The Micronaire (Mic) values of the cotton fiber were found to be fully compliant with the requirements of O‘zDST 620 – “Cotton fiber. Method for determining linear density and micronaire”, confirming the high quality of the fiber.

Furthermore, other analyzed parameters were also found to meet the requirements of O‘zDST 619, O‘zDST 625, and similar national standards. The results indicate that certain changes occurred in fiber quality due to the ginning process, and these changes were clearly observed when compared with the standards.

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