

# THE CHARACTERISTIC PERFORMANCE OF NATURALLY COLORED COTTON

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## Abstract

The performance of naturally colored cotton from fiber through yarn was investigated fundamentally. HVI data was used to determine the fiber properties of naturally colored cotton and to do a comparative study with regular upland cotton. The Uster Quickspin system was used to spin all the yarns for testing. Basic yarn quality of naturally colored cotton was analyzed and a comparative study with regular upland cotton was conducted.

## Introduction

In recent years, there has been renewed interest in naturally colored cotton because of the public's rising interest in environmental issues. According to US definition, colored cotton is cotton which grows naturally in color. Naturally colored cotton are not new, but have been around over 5,000 years. The yields of naturally colored cotton were low and the fiber was too short to be machine spun. But over the last 15 years, the research has led to improvements in yields and fiber quality--- fineness, length, strength, color intensity and variations. In 1988, commercially available naturally colored cotton with sufficient quality for spinning was seen in the markets, although the amount was extremely limited. The colors available are red, brown, tan, green and ivory (a new color). The yield is about 0.7 bales/acre for tan and even lower perhaps 0.5 bales/acre for brown and green. Currently, the naturally colored cotton is grown in Arizona, California, Texas and Virginia. The performance of naturally colored cotton is of great interest. Recent studies showed that they were usually shorter, weaker and finer than upland cotton, but they could be spun successfully into ring and rotor yarn for many applications. Also for a limited number of colors, the use of dyes and other chemicals can be omitted in textile finishing which can compensate for the high raw material price.

The objective of this study was to 1) characterize fiber and yarn performance of naturally colored cotton, 2) conduct a basic comparative study on fiber and yarn quality between naturally colored cotton and upland cotton to determine which variety of colored cotton needs to be improved to keep and maintain good quality, and 3) look for the effects of fiber properties of naturally colored cotton on yarn performance.

## Material and Methods

In order to determine naturally colored cotton fiber and yarn quality, four varieties of naturally colored cotton (one bale for each color from BC Cotton Inc.) namely, BC-1 tan, BC-2 brown, BC-3 green and BC-4 red were used. One bale of regular upland cotton was used. Forty subsamples of each bale of colored cotton and ten subsamples of upland cotton were used for HVI testing. HVI 3500/4000 system in the lab of the School of Textiles, Clemson University was used to determine fiber length, strength and Micronaire reading. The Uster Quickspin/MDTA 3 system was used during this study. The system is designed to allow the spinner to quickly analyze the effect of different cottons on yarn quality. The performances of Quickspin rotor yarn and conventional rotor spun yarn were compared.

The Quickspin system was operated by selecting a five-gram sample of raw cotton. The sample was passed through the MDTA 3 with Rotorring twice. The rotorring formed a one meter sliver of parallel fibers. The sliver sample was fed into the Quickspin open end box. The components and spinning settings were adjusted to match the actual spinning components used in normal rotor spinning yarn production. Yarn properties obtained were determined by Scott skein tester (10 tests for each yarn) and Statimat single-end tester (4 packages for each yarn, each package was tested 30 times). Samples from each of the colored cotton were subjected to the same Quickspin system and testing procedures under the same conditions. Eighteen count yarns were spun in this study. T-test was used to test the difference in mean values of yarn quality produced from the Quickspin system and conventional rotor spinning process. One-way analysis of variance of naturally colored cotton yarns and regular cotton yarns was employed to analyze the difference among varieties. Tukey's studentized range test was used for the separation of means.

## Results and Discussion

### 1) Fiber properties

The mean values of length, strength, elongation and Micronaire measurements of naturally colored cotton fiber and regular cotton fiber are shown in Table 1. The results could be summarized as follows:

Regarding the fiber length measurements, the four varieties of naturally colored cottons could be ranked in descending order according to their UHM inch: tan, brown, green and red. Comparing to the regular cotton, the brown cotton was the same length as the regular cotton and the tan cotton was longer than the regular cotton. The green and red cottons were shorter than the regular cotton. The difference in UI between the colored cotton and the regular upland cotton was very little (less than 3%) except for the tan cotton which had an extremely higher UI. Whereas for UR(%), the difference was also small (less than 6%) except for the red cotton which was lowest. From these results, it might be

concluded that the tan cotton was the longer fiber and the brown cotton was the same length as the regular upland cotton.

With regard to fiber strength measurements, the four varieties could be ranked in descending order as follows: tan, brown, green and red. Comparing to the regular cotton, the tan cotton was stronger and the brown cotton was the same strength as the regular cotton. However, the red and green cottons were weaker than the regular cotton.

Regarding the elongation, the four varieties could be ranked in descending orders as follows: red, green, brown and tan. The tan cotton had the similar elongation as the regular cotton. The other three varieties showed higher elongations. The difference between the red cotton and the regular cotton was large (more than 30%).

Regarding the fiber fineness and maturity, the four varieties could be ranked in descending order according to their Micronaire reading as follows: brown, red, tan and green. The difference between naturally colored cotton and upland cotton in Micronaire reading was very large (from 12% to 40%). It might be concluded that the naturally colored cottons were generally finer than upland cotton.

## 2) Yarn properties

The key areas in this study were targets for comparing the yarn tenacity and count-strength-product.

Table 2 shows the results of skein tests and single end yarn strength tests of the regular cotton yarns produced from the Quickspin and conventional rotor spinning system as well as the t-test results of comparing the difference between the quality of yarns. Comparing the tenacity of yarn, the statistical analysis indicated that there was no difference between yarns produced from different spinning systems ( $P=0.8176$ ). The yarn produced from the Quickspin system was quite acceptable and could be used to predicate yarn tenacity for conventional rotor spun yarn. With regard to the count-strength-product, the results indicated that the Quickspin yarns were weaker than the conventional rotor yarns.

Table 3 and Table 4 show the results of yarn testings of the naturally colored cotton yarns and the regular cotton yarns produced from the Quickspin system and the results of one analysis of variance and Tukey's studentized range test. With regard to the yarn tenacity, significant difference among the naturally colored cottons could be seen. Tukey's studentized range test indicated that the tan, brown and green cottons had the same level of quality in tenacity. The red cotton was weaker than the other three colored cottons. The regular cotton was stronger than the colored cottons, except the tan cotton which had the same level of tenacity as the regular cotton. Regarding the skein strength, differences in statistical significance were found among the naturally colored cottons. The four colored cottons were

separated into three groups with the tan cotton ranked highest and the red cotton ranked lowest. Comparing to the regular cotton, the same trend was shown which the tan cotton was ranked in the same group as the regular cotton. It could be concluded that the tan cotton was in the same level of yarn quality as the regular cotton. The high yarn quality of the tan cotton could be attributed to its good fiber quality (longer, stronger and finer). The brown and green cotton yarns have medium quality comparing to the tan cotton yarn. The red cotton yarn has the poorer quality which could be attributed to the poorer fiber quality (shorter, weaker and low maturity). The yarn quality of the colored cottons showed the same trend as their corresponding fiber properties.

## Conclusion

This basic study indicated that the naturally colored cottons were generally finer with Micronaire reading ranging from 2.6-3.4. The red and green cottons were generally weaker with strength about 21g/tex. The tan and brown cottons had about the same level of fiber strength as the regular cotton (from 26 to 29 g/tex). Also the red and green cotton fibers were shorter with UHM only 0.89-0.96 inch. The tan and brown cottons had about the same length range as the regular cotton from 1.01 to 1.14 inch. Yarn quality from the naturally colored cottons suggested that fiber properties had effects on corresponding yarn properties. The tan cotton had the best quality among the colored cottons. Yarn quality of the brown, green and red cottons were generally lower than the regular upland cotton.

## References

1. Philip Burnett. Cotton, naturally. Textile Horizons, February, 1995.
2. Joseph M. Yankey, Christiana Saaro, Gordon Williams, and Mona Qaud. Quickspin/MDTA
3. Cotton Textile Processing Conference, 1994 Beltwide Cotton Conferences.

Table 1. Fiber Data (HVI) of Naturally Colored Cotton ( Red, Brown, Tan and Green) and Regular Upland Cotton.

Sample	Tan	Brown	Green	Red	Upland
UHM(inch)	1.14	1.01	0.96	0.89	1.04
UI	90.3	80.7	79.2	78.2	80.3
UR(%)	46.6	49.4	48.5	44.4	47.0
Strength(g/tex)	29.2	25.7	21.4	21.1	24.6
Elongation(%)	6.3	7.4	7.9	8.4	6.4
Micronaire	2.8	3.6	2.6	2.9	4.4

Table 2. Comparisons of Yarn Quality of Upland Cotton from the Quickspin System and Conventional Rotor Spinning System.

Sample	Quickspin Rotor Yarn	Conventional Rotor Yarn	T-test (P-value)
Tenacity (g/den)	1.25	1.24	0.8130
CV% of Tenacity	10.42	11.39	
Count-Strength-Product	1604.4	1687.3	0.0001
CV% of Count-Strength-Product	1.34	2.10	

(The level of significance was 0.05)

Table 3. Yarn Properties of Naturally Colored Cotton.

Sample	Tenacity (g/den)	CV% of Tenacity	Count-Strength-Product	CV% of Count-Strength-Product
Tan	1.22 A	9.02	1634.5 A	3.94
Brown	1.16 A	8.09	1506.8 B	4.30
Green	1.16 A	9.04	1519.6 B	2.00
Red	0.96 B	10.66	1255.9 C	2.34
P-value	0.0001		0.0001	

(The level of significance was 0.05, Tukey's studentized range test was used)

Table 4. Comparisons of Yarn Quality of Naturally Colored Cotton and Regular Upland Cotton(Tukey's studentized range test).

Sample	Tenacity(g/den)	Count-Strength-Product
Upland	A	A
Tan	AB	A
Brown	B	B
Green	B	B
Red	C	C
P-value	0.0001	0.0001

(The level of significance was 0.05)