DEVELOPMENT OF COTTON/WOOL BLEND YARN FOR KNITWEAR

K. Caddel, D. Bean, H. Smith and E. Foster
International Textile Products & Apparel Consortium
Texas Tech University
Lubbock, Texas

Abstract

The knitwear consumer in the United States purchases millions of dollars in yarn, knit fabric, and knit garments each year. Cotton is considered to be a very comfortable fiber for spring and summer wear and the quality-conscious consumer has a preference for natural fibers. Do to the inherent properties of cotton and wool fibers a blend would enhance the quality of knitwear. The purpose of the study was to develop and physically test cotton/wool blend yarns suitable for knitted career apparel.

Six pima cotton/wool yarns were developed in blends of 80/20, 70/30, and 60/40. Each blend was produced in single and ply yarn. Yarns were dyed navy blue and tested for tenacity, strength, and elongation. Data analysis revealed differences between single and ply yarns with ply rating higher in abrasion resistance, pilling, and dimensional stability (wale), and lower in elongation.

Yarns were knitted into fabrics on a standard gauge home knitting machine and tested for bursting strength, abrasion and pilling resistance, stiffness, growth, and moisture regain. Results indicated differences between single and ply yarn fabrics in growth, stiffness, and abrasion. Ply fabrics (compared to single) stretched less in the course dimension for all fabrics and wale dimension for the 60/40. The ply was stiffer for the 80/20, and had lower abrasion resistance for the 70/30.

Findings show that through product development, plied cotton/wool blend yarns are marketable for knitted career apparel. The yarns produced in 20 pound of five colors were featured for the first time at an international knitting expo. All one hundred pounds of the yarn sold during the expo.

Introduction

The knitwear consumer in the United States purchases millions of dollars in yarn, knit fabric, and knit garments each year. The consumer chooses fiber content based on comfort, durability, and appearance properties. Interest in the development of fabrics from natural fiber blends and the demand for knitwear, particularly in the outerwear category, has increased significantly the last few years.

Cotton is considered to be a very comfortable fiber for spring and summer apparel. Because the quality-conscious consumer has a preference for natural fibers, the development of a cotton/wool blend for knitted apparel may be marketable to home knitters, home sewers, and ready-to-wear consumers.

In the research project, all stages of product development were followed according to Caldwell & Workman (1993). The product development included these stages: (a) idea generation and screening, (b) concept development and testing, (c) marketing strategy, (d) business analysis, (e) product development, (f) market testing, and (g) commercialization.

Discussion

Idea

The idea was to develop cotton/wool blend yarns to achieve a fabric weight wearable during Spring, Summer, and Fall. The concept was an end product suitable for knitted career apparel

Concept Development

The first step in the concept development was to produce 12 yarns (see Table 1) in various combinations. The yarns were developed on the cotton system at the International Textile Center (ITC) at Texas Tech University.

Only the cotton/wool *yarns* will be reported because the testing found the cotton/wool blends superior to the cotton/wool/rayon blends (Bean et al., 1996).

Objectives

The objectives of this study were to: (a) test physical properties of fibers, (b) produce and test cotton/wool intimate blends in single and two-ply yarns, (c) produce a knit fabric from each yarn type, (d) test physical properties of fabrics, and (e) survey hand and machine knitters.

For each bale of cotton received the ITC, a standard set of tests are taken on the High Volume Instrument equipment. The physical properties tested for the fibers were strength, elongation, length, uniformity ratio, micronaire, reflectance, yellowness, and color grade. See Table 2.

A luster in the fiber was preferred. This can usually be achieved by mercerizing cotton. However, this was not possible because the mercerizing process weakens the wool. The intimate-blended yarns utilized Texas Pima cotton and wool fibers.

The yarn was developed as a high twist, sport weight yarn with approximately 4,500 yards per pound. The yarn structure consisted of single and 2-ply in cotton/wool. The percentages ranged from 80-20, 70-30, and 60-40. See Table 3. The yarns were package-dyed navy blue using a reactive dye. To describe the results of yarn testing, an

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:776-778 (1998)
National Cotton Council, Memphis TN

advantage direction chart (see Figure 1) is used. There were more advantages in the plied yarns compared to the singles. Two properties, yarn number and tenacity, showed the same results for single and plied yarns.

The fabric was developed using fabric swatches prepared on a standard gauge knitting machine, commonly used by home knitters. The gauge considered desirable was 9 stitches and 12 rows per inch. The fabric was knitted in a stockinette stitch, also known as knit stitch in the textile industry. Six fabric samples, three single and three plied, of 80-20, 70-30, and 60-40 were knitted to approximately 1-1/2 yard lengths. The samples were prepared for the physical tests. See Table 4. The fabric samples were tested at ITC according to the American Society for Testing Materials (ASTM). Six physical tests shown were administered. Physical testing of the fabrics included ball bursting strength, abrasion, pilling, percentage growth in the wale and course direction for 60 seconds and 1 hour, stiffness in pounds, and percentage in moisture regain. See Table 5.

The statistical analyses used on the data were t-tests and analyses of variance among singles, among plies, and between single-ply of the same fiber percentage. If a significant F was found, a post hoc comparison test, Student-Newman-Keuls, was applied where significant differences were located.

The single yarn in all percentage combinations was better than the plied in pilling, however all showed considerable pilling. *The results of the yarn and fabric tests indicated that pilling ranged from severe to moderate creating a problem for use and sale of the product. Additional tests were administered to determine if the cotton or the wool fiber caused the pilling. The findings showed the cotton fiber to be the problem. An adjustment was made in the yarn utilizing a higher grade cotton with a longer length and an additional twist. The pilling resistance test improved to a rating of moderate to slight.* It was determined that the 70-30 percentage had the lowest growth on the 60 second test. The 80-20 was less stiff than the other percentages and the 60-40 had the higher percentage of moisture regain. See Table 6. The plied yarn results showed that the 70-30 blend had the highest resistance to pilling. Referring to both tests for growth, the 80-20 was the only blend to sustain less growth. Again, moisture regain was associated with the percentage of wool. Moisture regain results indicated that the 60-40 fabric had the most moisture gain. See Table 7.

Marketing Strategy

A packet including 1/2 pound of one of the 2 ply yarns, 80-20, 70-30, and 60-40 in cotton/wool and 80-5-15, 70-15-15, and 60-25-15 in cotton/wool/rayon, knitting instructions, a questionnaire, and a return envelope was distributed to hand and machine knitters in the Metroplex area of Dallas/Fort Worth and hand knitters in Lubbock, Texas. The 60 knitters were asked to knit a swatch of fabric and then respond to the questionnaire. The questionnaire contained five sections. Section one asked the participant to assess the knitting, visual, and comfort characteristics of the yarn and resulting fabric. Section two referred to the knitters' expectations of the fabric in regard to physical properties. Section three rated the likelihood-to-purchase the yarn, and Section four addressed the fiber preference. Demographics of the knitters were obtained through Section five.

The results (see Figures 2-6) from the data collected on 40 home knitters (20 machine and 20 hand) responses to the questionnaire revealed that all the yarns in the various fiber percentages were easy to knit. Ninety-five percent liked the feel of the fabric. The knitters ranked weight and comfort suitability of the fabric for spring/summer apparel at 87.5% with consecutive rating of 89%. The participants expected the fabric to pill, grow during wear, shrink when washed, and to bias. Eighty-five percent showed they would purchase the yarn if the label carried a machine washable tag and 83% would pay $15 a pound for the yarn. Natural and/or natural-synthetic blends were preferred over synthetic yarns and the knitters believed that the natural fibers have better qualities. Demographics of the knitters revealed that 39 females and one male, 40% were unemployed or retired with 55% 46 to 56 years old. Fifty percent had a bachelors degree and 18% had a master or doctorate degree. Forty-three percent showed a yearly income of $60,000 or above.

From the findings it was concluded that 70% cotton/30% wool blend of 2-ply yarn was selected for marketing following the product development. This yarn had the highest resistance to pilling of the plied yarns, the lowest growth in the course direction on the 60 second test, and was considered the most suitable yarn to achieve a lightweight apparel fabric by the home knitters.

Market Testing

A yarn distributor for the home knitting market segment provided samples for color matching. After approval of the colors, the yarns were dyed in red, black, white, teal, and royal blue, in the 70-30 cotton/wool blend. Twenty pounds per color were manufactured for the market test. The yarns were featured for the first time at the Third British-American Machine Knitting Expo in September, 1996. One thousand consumers and representatives from business and industry attended the four day event. All one hundred pounds of the cotton/wool yarn were sold by noon on the second day.

Summary

Commercialization

The researchers are currently searching for a producer that can manufacture small quantities of the 70-30 cotton/wool blend for the home knitting market and large quantities for apparel manufacturers (Luters 1997). The utilization of the stages of product development in the research project has

shown that this product has potential for profitable sales in the marketplace.

References

Caldwell, L. F., and Workman, J. E. 1993. New product development: Testing the concept of customized patterns. Clothing and Textiles Research Journal. 11(4): 1-6.

Bean, E., Caddel, K., Smith, H. R., and Foster, E. R. 1995-1996. Development of cotton/wool blend yarns for the home knitting market. Annual Progress Report for the Texas Food and Fibers Commission.

Luters, G. 1997. A yarn is born. Machine Knitters Source. 13(76): 16-17.

Table 1. Physical Description of the Twelve Yarns Fabrics

Fabric Number	Yarn	Percentage	Fiber content
1	Single	80-20	cotton/wool
2		70-30	
3		60-40	
4		80-5-15	cotton/wool/rayon
5		70-15-15	
6		60-25-1	
7	Plied	80-20	cotton/wool
8		70-30	
9		60-40	
10		80-5-15	cotton/wool/rayon
11		70-15-15	
12		60-25-15	

Table 2. Physical Properties of the Fibers

Tests	Cotton	Wool
Strength (g/tex)	40.9	
Elongation%	6.8	
Length (inches)	1.4	1.7
Uniformity Ratio	88.1	
Micronaire	4.2	
Reflectance, Rd	66.8	
Yellowness, +b	12.3	
Color Grade	33.0	
Coefficient of Variaion		35.4

Table 3. Yarn Production

Yarn Structure	Fiber Percentage	Fiber Content
Single and 2-Ply	80-20	Cotton/Wool
	70-30	
	60-40	

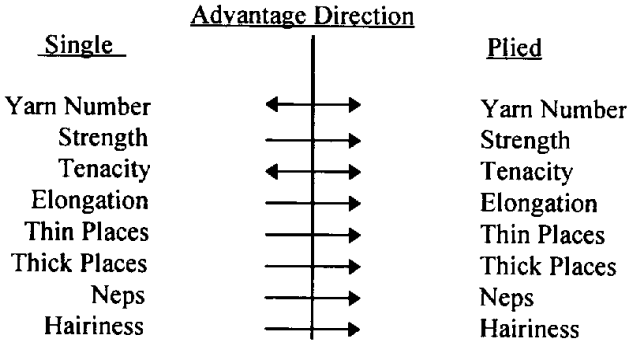

Figure 1. Yarn Properties and Test Results

Table 4. Fabric Development

No	Yarn	Fabric	Percentage of Fiber Content
1	Single	Filling Knit	80 cotton/20 wool
2	Single	Filling Knit	70 cotton/30 wool
3	Single	Filling Knit	60 cotton/40 wool
4	Plied	Filling Knit	80 cotton/20 wool
5	Plied	Filling Knit	70 cotton/30 wool
6	Plied	Filling Knit	60 cotton/40 wool

Table 5. Fabric Testing (ASTM Test Methods)

Physical Test	Method
Ball Bursting Strength	ASTM D373-89
Abrasion Resistance (flat)	ASTM D3886-94
Pilling Resistance	ASTM D3512-94
Stiffness	ASTM D4032-94
Growth	ASTM D2594-87
Moisture Regain	ASTM D2654-95

Table 6. Single Yarn Fabric Results

Test	Results*
Growth - (Course)	
60 seconds	80-20
	70-30 A (lowest growth)
	60-40 B
Stiffness	80-20 A (less stiff)
	70-30 B
	60-40 B
Moisture Regain	80-20 C
	70-30 B
	60-40 A (higher regain)

*p≤.05

Table 7. Ply Yarn Fabric Results

Test	Results*
Pilling Resistance	80-20 B
	70-30 A (highest resistance)
	60-40 B
Growth - (Course)	80-20 A (lowest growth)
60 second	70-30 A (lowest growth)
	60-40 B
1 hour	80-20 A (lowest growth
	70-30 B
	60-40 B
Moisture Regain	80-20 C
	70-30 B
	60-40 A (higher regain)

*p = .0001

Percentage

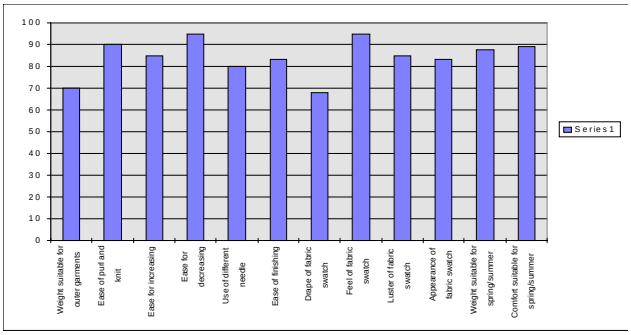

Figure 2. Knitting, Visual, and Comfort

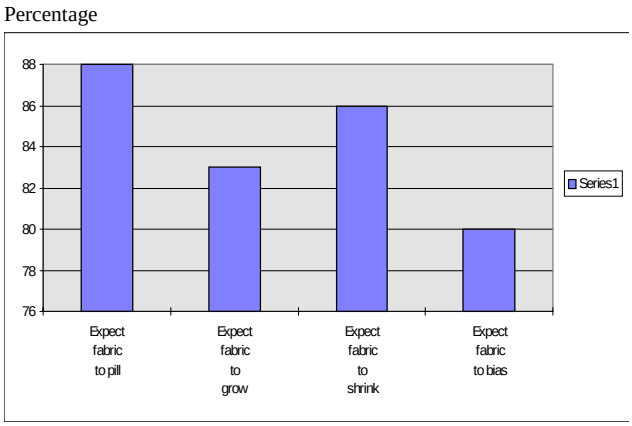

Figure 3. Knitters' Expectations of Fabric

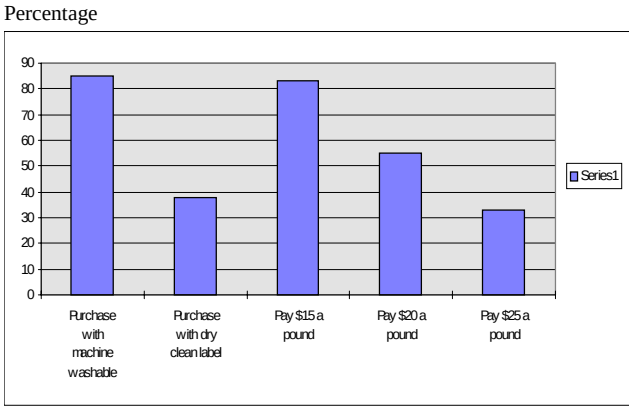

Figure 4. Likelihood-to-Purchase

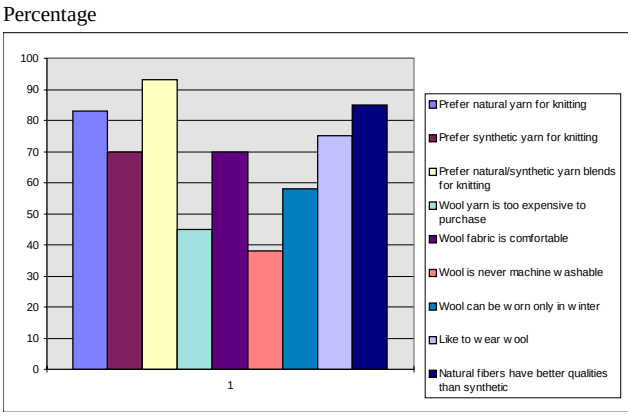

Figure 5. Fiber Preference

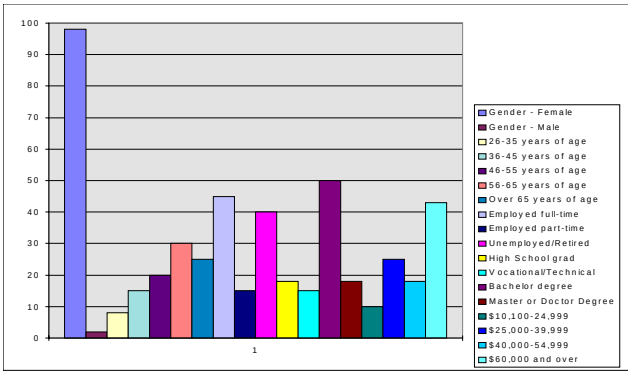

Figure 6. Demographics