

A comparative study of machine knitted cotton fabrics

■ RENU SINGH AND RITU PANDEY

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■ **ABSTRACT** : A comparative study of three types of machine knitted cotton fabrics viz., plain, rib and tuck was carried out in order to find out the most serviceable knit stitch. The present study moves around the raw material and knit stitches used for the knitting of the samples. All the knitted fabrics were produced by using cotton yarn. The machine parameters were also kept constant for the manufacturing of all the three types of fabrics. The experimental research design was used for conducting present investigation. The performance study of the fabric was done on the basis of physical tests related to durability, strength, maintenance, aesthetic appearance etc. The results reveal that variable (three knit stitches) had significant effect on the performance of the fabrics. It was observed from the study that plain knit stitch was the best serviceable knit stitch among the stitches.

■ **KEY WORDS**: Knit stitch, Plain stitch, Rib stitch, Tucks stitch, Serviceability, Physical properties, Cotton yarn, Machine knitting, Durability, Maintenance

See end of the paper for authors' affiliations

RENU SINGH

Department of Home Science, University of Allahabad, ALLAHABAD (U.P.) INDIA

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Almost from the beginning of the civilization, clothing need of human beings is fulfilled by four basic fabric manufacturing techniques namely interweaving, interlooping, interwining and interbonding. Among the four, use of the last two fabric construction techniques is limited in human clothing. From ancient period, man has attempted to make his clothes and fabrics by reproducing the vivid interlacement of yarns through weaving. The technique of knitting is not as old as that of weaving but unique capability of knitting to manufacture shaped and form fitting articles has been utilized for centuries.

Knitted fabrics are preferred in many types of clothing because of its extensibility, lightweight, warmth, wrinkle resistance and ease of care (Shahid *et al.*, 2010). Knitted garments are becoming popular as compared to

woven made ups because of their good aesthetic properties and comparative lower production cost. Unlike woven or bonded fabrics, knitted fabrics possess a high degree of elasticity and recovery. Knitted garment is easily packable. It remains after a day of wear as fresh as when it was donned in the morning, creases in knitted fabric brush right out. These fabrics are soft and light in weight and easy to care. It has good drapability and comfort properties. Thus demand for knitted articles has grown tremendously within recent years because of increased versatility of techniques, the adaptability of new fibres and growth in consumer demand for wrinkle resistance, stretchable, snug fitting fabrics, particularly in the greatly expanding areas of sports-wear and other casual wear apparel.

It is the youngest, most adventurous, most flexible,

versatile and potentially all embracing system of producing fabrics of all possible descriptions. A unique feature of knitting process is the possibility of producing complete garment directly on the knitting machine (Deshpande *et al.*, 1994).

While renewed buoyancy in garment industry is helped by a sharp improvement in fabric knitting construction technology, therefore, to gain a better understanding about knitting, a comparative study was undertaken. The emphasis has been laid on introducing three basic knit stitches for the purpose of comparing and investigating its effect on fabric properties. Such systematic and technical information might improve prospects of marketing and sales of the knitted products on the basis of the serviceability of fabric.

Hence, keeping all above points in mind the present study has been undertaken with the following objectives:

- To prepare the samples of three knit stitches *viz.*, plain, rib and tuck.
- To test the physical properties of knitted samples.
- To evaluate the most serviceable knit stitch based on physical properties.

Related work :

As knit fabrics are produced on different machines with various conditions to produce different types of fabric, they wear different qualities (Chen *et al.*, 1992). Areal density is the measure of mass per unit area of the fabric. Usually knit fabrics with tuck stitches appear thicker than the fabric having only knit stitches due to accumulation of yarns at the tucking places (Ajgaonkar, 1998). The effect of knit structures on their areal density has been analyzed by many researchers (Emirhanove and Kavusturan, 2008).

Islam (2014) studied on the effect of increased tuck and miss loops on spirality of single jersey fabric. They also mentioned that the spirality of fabric changed due to the change of stitch length and count variation. Influence of stitch length on dimensional properties like CPI, WPI, GSM, thickness factor and also the change of physical properties such as air permeability and water absorbency, shrinkage, spirality (Khalil and Soliman, 2014). Suitability of cotton elastomeric core spun yarn by analyzing dimensional stability and geometrical attributes of knitted structure (Kumar and Sampath, 2013). Impact of different knit structure on the

dimensional properties of knitted fabric (Emirhanove and Kavusturan, 2008; Karba *et al.*, 2003 and Asif *et al.*, 2015). Influence of different fibre on the dimensional properties of knit fabric (Sakthivel and Anbumani, 2012). Effect of knit structure on the areal density of knit fabric with stitch length variation on the increment of tuck loop and mentioned that only limited numbers of researches were carried out to investigate such effects (Rahman and Smriti, 2015).

De Araujo and Smith (1989) studied the effect of spinning technology on the spirality of jersey fabrics for some 100% cotton and 50/50 cotton/polyester blend yarns. They found that the blend yarns produce less spirality than 100% cotton yarns. Moreover they have mentioned that each spinning technology influences on the degree of spirality of knit fabrics (De Araujo and Smith, 1989).

Effect of stitch length on knit fabric structure plays a vital role on its properties (Anand, 2000). Stitch/loop length is the fundamental unit which controls all the properties of weft knitted fabrics. Mainly stitch length and knit structure affects all the dimensional, comfort, handle and other properties (Nizam and Hossain, 2015).

■ RESEARCH METHODS

Textile material used:

Cotton yarn was used for the production of the three types of knitted fabrics *i.e.* plain, rib and tuck.

Procurement of the sample:

All the three knitted fabrics were manufactured at Caplon Industries Ltd., using circular weft knitting machine. The machine parameters were as follows:

No of needles	120
Type of needle	Latch needle
Cylinder diameter	3.5"
Needle mark	71.60 Hofa
Machine gauge	11 gg
Motion	Auto stop

For present research work, single jersey fabric was made with the help of plain knit stitch while rib fabric was constructed by using 1 x 1 rib knit structure. Tuck knitted sample was also produced on the same weft knitting machine. For this construction, needles were fitted only half way towards clearing height to tuck height.

Locale of the study:

The study was conducted in the Textile laboratory of Department of Home Science, C.S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh.

Experimental procedure:

Laboratory experiment was carried out under following steps:

Preparation of sample:

The physical properties of samples were studied after conditioning it at the temperature of $27 \pm 2^{\circ}\text{C}$ and humidity 66 ± 2 per cent for 24 hour.

Determination of physical properties:

Various physical properties of the yarn and fabrics were evaluated. Stitch density, fabric thickness, moisture content and wicking ability tests were carried out for determination of comfort level provided by each fabric. Durability and strength of prepared samples were measured in terms of fabric abrasion resistance and bursting strength. Crimp per cent and shrinkage property were evaluated to optimize the required maintenance. Aesthetic property of the samples was determined by pilling propensity. Each test was carried out for 5 samples and average value was calculated.

RESEARCH FINDINGS AND DISCUSSION

The results are discussed in relation to physical properties of yarn as well as knitted fabrics. Cost of production of prepared samples was also evaluated.

Physical properties of yarn :

The important characteristics of yarns which were evaluated to determine its quality were as follows:

The yarn having two plies was used. The count of

the yarn was 30 s. Twist per inch of the yarn found to be 16 in 'S' direction. Yarn was also tested for yarn tenacity, strength and elongation. The values of yarn strength and tenacity were found to be 384 g and 12.8 g/tex, respectively. The yarn was elongated about 16 per cent (Table 1).

Physical properties of fabric:

For the judgment of the most suitable fabric for different end uses, it should have certain desirable properties. Hence testing of fabric for quality is important and essential. Therefore for determining the best knit stitch the knitted fabrics were subjected to different tests and findings are discussed as follows:

Comfort related properties :*Stitch density.*

The stitch density is expressed in terms of courses per inch and wales per inch (Spencer, 2001). It was observed from the Table 2 that plain knit fabric has the highest stitch density while rib fabric has the lowest stitch density among all the stitches. Maximum density of stitches in plain knit indicates its maximum covering power.

Fabric thickness:

In textiles, fabric thickness is the distance between the upper and lower surface of the material, measured under a specific pressure (Lyle, 1977). The thickness of the fabric is measured at pressure 2g/cm^2 and it can be used to monitor the chemistry of fabric (Grover and Hambi, 1984). The evidence from the Table 2 shows that thickness value was the lowest for plain fabric as compared to tuck and rib fabrics. 1 x 1 rib construction had length wise ridges on both sides of the fabric. Because of that, rib fabric was the thickest fabric among

Table 1 : Physical properties of yarn

Sr. No.	Yarn	Physical properties				
		Yarn count (tex system)	Twist per inch (TPI)	Yarn strength (g)	Yarn tenacity (g/tex)	Elongation per cent (%)
1.	Cotton	30	16	384	12.8	16

Table 2 : Comfort determining properties

Sr. No.	Knit stitches	Stitch density (loops/inch ²)	Fabric thickness (mm)	Fabric weight(g/m ²)	Moisture content (%)	Wicking ability (%)
1.	Plain	504.4	0.86	168.8	4.35	125.99
2.	Rib	246.8	1.32	180.6	3.57	84.64
3.	Tuck	452.2	1.22	230.0	3.98	24.95

the rest of the samples. Tuck fabric has moderate thickness.

Fabric weight:

Average fabric weight of plain, rib and tuck fabrics was 168.8 g/m², 180.6 g/m² and 230 g/m², respectively. While comparing the weight of all the three types of fabrics, it was found that plain knitted fabric has minimum while tuck knitted fabric has maximum fabric weight. Because of less fabric weight, the plain knitted fabric is less bulky, finer and easy to put on and take off.

Moisture content:

From the Table 2 it can be observed that moisture content values were 4.35 %, 3.57 % and 3.98 % for plain, rib and tuck knitted fabrics, respectively. It was found that according to mean values, plain construction had maximum moisture content values followed by rib fabrics and tuck fabrics. As moisture absorption is related to ease of dye ability and freedom from built up of static electricity, use of plain stitch will make the fabric easy to dye and comfortable to wear.

Wicking ability:

Wicking ability of the fabric is the ability that tends water to climb up through capillary system of the fabric. A simple measure of fabric wetness can truly reflect comfort sensation of wearer (Lyle, 1977). The results were evaluated on the basis of percentage of water absorbed by the fabric through its capillary system. The Table 2 depicts that the wicking ability of plain fabric was maximum i.e. 125.99 %. Rib fabric had 84.64 %, while tuck fabric had 24.95 % wicking ability.

Durability and strength determining properties :

Abrasion resistance:

While comparing respective fabrics containing three different knit stitches it was observed that among all the fabric samples, plain fabric showed least weight loss and resulted in highest abrasion resistance followed by rib and tuck fabrics. The average weight loss recorded for plain, rib and tuck fabrics was 0.32 %, 0.71 % and 0.81 %, respectively.

Bursting strength:

Bursting strength is the measure of the resistance for the fabric to the multidirectional flow of pressure. Bursting strength of cotton knitted fabric was carried out for all the fabrics in the similar directions and the obtained results were compared. It was found that rib knitted fabric showed maximum bursting strength (Table 3).

Maintenance and Aesthetic related properties :

Crimp per cent:

Crimp per cent is defined as the mean difference between straightened thread length and the distance between the ends of the thread within the cloth expressed as per cent (Angappan and Gopalkrishnan, 1993). Crimp per cent is measure of waviness in yarn (Grover and Hambi, 1984). This property was tested and the results are given in the Table 4. The table shows that plain fabric had maximum crimp, while rib fabric had minimum crimp per cent. The reason for it may be that the crimp of the fabric may be affected by loop length and stitch density of the fabric because maximum stitch density may results in maximum knicks or higher crimp per cent.

Fabric shrinkage:

Fabric shrinkage is the most common problem of knitted fabrics. For least required maintenance fabric should have least fabric shrinkage. From the Table 4 it

Table 3 : Strength determining properties			
Sr. No.	Knit stitches	Abrasion loss (%)	Bursting strength (pound)
1.	Plain	0.32	8.56
2.	Rib	0.71	9.14
3.	Tuck	0.81	8.14

Table 4 : Maintenance and aesthetic related properties				
Sr. No.	Knit stitches	Crimp per cent (%)	Shrinkage (%)	Pilling propensity (no. of balls)
1.	Plain	372.6	11.84	6(S/4)
2.	Rib	183.2	17.04	23(S/2)
3.	Tuck	333.0	10.38	3(S/5)

can be observed that the average value of shrinkage per cent for plain fabric was 11.84 %. Similarly for rib fabric and tuck fabric it was 17.04 % and 10.38 %, respectively. It was found that rib fabric had higher tendency to shrink while tuck fabric had minimum shrinkage per cent. Similar results were also found by Pandey *et al.* (1999), who reported that hand knitted tuck stitch had least shrinkage followed by plain stitch (Pandey *et al.*, 1999).

Pilling propensity:

Pilling is the fabric surface object characterized by little fibre balls clinging to cloth surface and giving a garment unsightly appearance. It is evident from the Table 4 that tuck fabric tend to slight pilling. The plain construction performs moderate pilling that is more than tuck construction. Rib fabrics showed maximum pilling propensity, thus surface performance of rib fabric was not good. Aesthetic property of tuck fabric was found excellent as compared to plain and rib fabric.

Cost of production:

The cost of raw material to produce 1 m² tuck fabric was maximum *i.e.* Rs. 27.54. Cost of production for rib fabrics was found to be approximately Rs. 25.52 per m² fabric. Results emphasizes that the plain knit construction had lowered overhead expenditure because of less yarn consumption. It also reduces power and labour consumption thus it indicates higher rate of production.

Conclusion :

Cotton has been used in manufacturing of clothing for centuries. The grace of cotton can be enhanced using different knit stitches. The present investigation was related to the testing of yarn and fabric properties of cotton knitted samples. Yarn having same specification was used for preparation of all the three types of fabrics. For the fulfillment of the main purpose of the study *i.e.* to explore the effect of knit stitches on the performance of machine knitted cotton fabrics, physical properties related to aesthetics, comfort, strength and maintenance were evaluated.

The result of the investigation shows that performance of plain fabric was the best among all because it shows higher values in most of the physical properties such as higher wicking ability, moisture content, abrasion resistance, and crimp per cent. It has moderate pilling propensity and less fabric weight and thickness.

All of the above properties will make the fabric more durable, comfortable and easy to maintain. The plain stitch fabric was found to be less costly in this way it will be benefiting the consumers as well as producers. Tendency to generate least pills will enhance aesthetic property of tuck fabric. Visual investigation shows that tuck stitch was the most beautiful and decorative stitch. However, strength was maximum in rib stitch fabric.

Thus it may be concluded that plain fabric is the most serviceable as well as economical. Rib knit fabric is moderate in service while tuck fabric is good in appearance. Findings of the study may be of great importance to the knitters. They can increase the range of their products by introducing plain knits for apparels made from cotton yarn on the weft knitting machine.

Authors' affiliations:

RITU PANDEY, Department of Textiles and Clothing, C.S.A. University of Agriculture and Technology, KANPUR (U.P.) INDIA

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