New knitted fabric concepts for denim products

A Marmaralı¹, G Ertekin¹, N Oğlakçoğlu¹, M Kertmen² and İ Seçil Aydın²
¹ Ege University, Faculty of Engineering, Department of Textile Engineering, İzmir, Turkey
² İskur Tekstil Enerji Tic. ve San. A.Ş., Kahramanmaraş, Turkey

E-mail: arzu.marmarali@ege.edu.tr

Abstract. “Denim” like knitted fabric is a new trend combining the appearance of woven denim with the knitted structures’ characteristics such as flexibility, softness, wrinkle resistance, user-friendliness, and comfortable. According to the requirements of markets, it can be obviously seen that, this fabric will be a new era for denim industry which can be competitive with woven denim garments. This study presents general information and literature survey about denim production, knitted denim structures and their characteristics.

1. Introduction
Denim garments have been fashionable in the world since mid-19th century. This is something to come together of both the fabric and colour. They have several advantages compared with other types of clothing. All the adjectives: comfortable, adventurous, relaxing, attractive, aggressive, smart, casual, dynamic, energetic, aesthetically appealing, timelessly fashionable or creative define denim not only as a style in fashion but as something more: a lifestyle. This explains why generation after generation finds the denims as a material of first choice for casual wear [1].

The denim fabric was used for jeans and first for the miners, ranch hands and farmers. They were durable and a man could spend all day panning without giving a thought to his pants. The original production is “twill weave” which is accepted as made dirt and stains less visible, flexible and comfortable. It is produced by yarn-dyed (originally pure indigo dye: rich-purplish-blue colour) spun yarns of cotton or its synthetic blends (Fig.1) [2]. It is a characteristic of most indigo denim that only the warp threads are dyed, whereas the colour of weft threads remains plain white. As a result of the warp-faced twill weaving, one side of the fabric shows the coloured warp threads and the other side shows the white weft threads [3].
Figure 1. Woven denim fabric [2]

Such woven denim fabrics have highly durability and dimensional stability, whereas they have less extensibility to accommodate body movement and they are quite susceptible to wrinkling [4]. Knitted fabric has special properties that make it suitable for creating a wide range of garments and accessories like tights, underwear and other close fitting garments [5, 6]. It is, therefore, an object of new investigations to provide “denim” like knitted fabrics, which overcomes the above-noted disadvantages (Fig.2). The previous experiences proved that a denim fabric having good wrinkle resistance and improved stretch which contribute to the ease of care and long lasting neat appearance.

Furthermore, the knitted method improves the softness and comfort ability of the fabrics and, if indigo dyed yarn is used, colour-fading feature can be also achieved [4].

Figure 2. “Denim” like knitted fabrics [7, 8]

One of the researches indicated that "denim" effect on knitted fabric can be produced by three types of technologies: a) Float plated technology, b) Thread fleece, c) Interlock plated jacquard. In float plated technology, the structure with knit and float stitches by using knit and sinker cams as well as sinkers to do a knit on one side of the fabric and a very tight float on the other where the float gives the woven effects. Depending on the cylinder cam arrangement, the machine can generate one-, two- and three-needle floats. The production technique of 2-thread fleece fabric is given in Fig.3. By using the interlock plated jacquard technique, it is not possible to get the denim effect and the denim fabric’s stiffness [4].
“Denim” like knitted fabrics are preferable due to the softness, breathability, flexibility, wrinkle resistance, user-friendliness, comfortability and fashionable characteristics. It is also available in attractive indigo blue shades and is made for variety of applications. The comfort ability of “denim” like knitted fabrics as well as its stretch ability makes the fabric mold and move easily with body movement thereby creating huge demand to the customers (Fig.4) [5].

Figure 3. Needle notation diagram and cam arrangement of 2-thread fleece fabric [9]

Figure 4. Examples of “denim” like knitted clothes [10-13]

2. Literature
The literature survey showed that there are some patents about the production process of “denim” like knitted fabrics and products as follows:

Quinnen, developed a dyeing process for the indigo dyed cotton yarn suitable for machine knitting and knitted fabrics. The dyeing process is comprising passing a cotton rope consisting of a plurality of yarn threads through a plurality of baths of indigo dyed liquor, allowing the dye to oxidize by
exposure to air between each bath, and winding each of the said thread separately to provide an indigo dyed yarn in a form suitable for knitting. The threads are wound onto individual spools, which may be rotated on a common shaft, or by individual motors. The indigo-dyed knitted cotton fabric produced shows the fading by abrasion, rather than washing out, normally associated with denim [14].

Rastogi and Oswal developed a process for the preparation of indigo dyed yarn for use in the manufacture of knitted fabric by a knitting machine comprising in the steps of, forming a dyed rope of yarn by the steps of indigo dyeing; individualizing the yarn of said dyed rope; forming separate packages of the yarn on separate spools of fixed ends; preparing individual hanks of each yarn end of each spool by hank maker; converting said hanks into individual cones of single yarn [15].

Shin designed denim-like knitted trousers which were suitable to each season and compared their properties to woven denim fabrics. He reported that this type of trouser was more advantageous than woven type except dimensional stability and strength properties [16].

Besides patents, there are also scientific researches about investigation of “denim” like knitted fabrics’ characteristics, however they are relatively few.

Gokarneshan et al. studied the denim effect in different knit structures, such as float plated, 2 thread fleece and single jersey. They measured the extension, spirality, cpi, wpi, loop length, weight, fastness (to dry cleaning, laundering, perspiration and rubbing) of the fabrics. The results show that, the fastness values of all three knit structures are similarly high. The spirality characteristics of the float plated and two thread fleece fabrics are less. Loop length values are same and cpi/wpi for float plated and single jersey fabrics are higher than two thread fleece yarn. Float plated fabric has the lowest extension characteristic. The float plated fabric has similar thickness and weight values compared with woven denim fabric. In the second part of their studies, they applied enzyme wash to float plated and 2 thread fleece fabrics and measured again the fastness properties of these fabrics. They stated that they give similar fastness values after enzyme wash [4].

Değirmenci and Çelik were the other researchers having various studies on “denim” like knitted fabric. In one of their study, they applied a questionnaire about denim clothes and tried to obtain the similarities of knitted denim and traditional woven denim fabrics. Consumer preferences, colour, fashion, price, comfort, elasticity, durability etc. characteristics were led in the questionnaire. According to the results of questionnaire it is demonstrated that durability is the most important parameter for the students. Price, elasticity and comfort are also important [17].

In another study, they investigated the effect of laundering on the dimensional stability of the “denim” like knitted fabrics and aimed to determine the optimum structural parameters for more resistant knitted fabric after several launderings without losing their denim view. They produced eighteen “denim” like knitted fabrics by varying the yarn count and the material used as fleece (inlay) yarn. They stated that the laundering has significant effect on the dimensional stability of the fabrics and the shrinkage values were acceptable according to the standard AATCC 135. According to their results, using polyester yarn and/or blended yarns as fleece yarn was quite suitable to design dimensionally stable denim-like knitted fabric [18].

They also analysed the compatibility of denim viewed knitted fabrics to the use as denim jeans according to the strength and extension properties of these fabrics in a further study. In the fabric production, regenerated cellulosic fibres were used and they compared the test results with the fabrics produced by cotton fibre. They found that all the fabrics were compatible to the use according to the strength values (TS 11266). The lengthwise extension of the samples was notably high so the clothes which would be produced by these fabrics can withstand to burst pressure without any hole. The raw material used as fleece yarn did not affect bursting strength parameter significantly. The count of fleece yarn was more important than the raw material of fleece yarn on the extension of the fabrics [19]. The effects of raw material and count of fleece yarn on thermal comfort properties of these fabrics were also examined, as well. They measured the thermal comfort properties such as air permeability, water vapor permeability, thermal resistance and thermal absorptivity. They found that jeggings manufactured by the use of “denim” like knitted fabrics have considerably similar look to those of the traditional woven denim fabrics. According to test results, when the fleece yarn thickness
decreased, the air permeability increased. The hairiness of the fleecy yarn was effective on the air permeability of the fabric. The most air permeable fabric was fabric produced with 30/1Ne 100% viscose fleecy yarn. Additionally, it was found that the fabrics which have bamboo and modal fleecy yarns are suitable for summer wear [20].

Didar et al. produced knit and tuck denim knitted fabrics and compared with conventional woven denim in accordance with physical (weight, pilling, bursting strength, shrinkage, spirality and air permeability) and colour fastness properties (to rubbing and washing). The results indicated that the shrinkage % values of the denim knit products are higher than woven denim fabric. The spirality for knit denim is slightly more than tuck denim, whereas both the fabric shows greater spirality compared to woven denim. Colour fastness to wash and rubbing for both knitted denim fabric is better than woven denim fabric. They found that the developed knitted fabrics (tuck denim and knit denim) are softer and comfortable as well as less complicated to be produced [5].

3. Conclusion
People’ lives have changed, and they in particular need clothes that look good, suit their style, and perform well in all the moments of their life, from professional, to active, family and social life. Knitted fabrics not only possess stretch and provide freedom of movement, but they also have good handle and easily transmit vapor from the body. “Denim” like knitted fabric is a new trend combining the appearance of woven denim with the knitted structures’ characteristics such as flexibility, softness and comfortable. In looking at industry mega trends, it is no secret that active wear garments have been increasing, particularly yoga wear, and sales of denim have been declining as a result. The companies wanted do something as part of the denim industry so that denim could capitalize on the active trend [12]. According to the requirements of markets, it can be obviously seen that, this fabric will be a new era for denim industry which can be competitive with woven denim garments.

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