Panorama of ecofriendly naturally colour cotton

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Two genotypes of naturally brown coloured cotton yarns, viz. Dharwad Desi Colour Cotton–1 (DDCC-1) and Dharwad Brown Hirsutum–250 (DBH-250) were shot on handloom with white cotton and filature silk (Muga, Mulberry and Tasar) to produce user and ecofriendly fabrics. Japanese Kawabata Evaluation System was used to assess these union fabrics for their performance. Union fabrics showed higher tensile, bending, shear, compressional and surface property values indicating the fabrics having low bending rigidity & fabric density, greater flexural rigidity than their corresponding control samples. Koshi (stiffness), Numeri (smoothness), Fukurami (fullness and softness) and Sofutosa (softness) were the Primary Hand Values of KES-FB in turn assisted to rate the Total Hand Value (THV). The THV expressed that these union fabrics are most suitable (good to excellent) for women’s winter thin dress and fairly suitable (fair to good) for women’s winter suits. Therefore, it is a boon for cotton cultivators to grow colour cotton on commercial scale to sustain in both domestic and international market as well as support the handloom sector.

Key words: Colour cotton, Surface properties, Tensile properties, Union fabrics, Ecofriendly colour cotton, Natural colour cotton

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Cotton is also called as fabric of India since it has played a very important role in the lives of Indians. India holds the largest area of 8 m ha under cotton cultivation and ranked third in world’s cotton production, next to China & USA and second largest consumer of cotton. Majority of cotton grown commercially in the world is white lint but in recent years the colour linted cotton has gained popularity. Compared to white cotton, naturally colour linted cotton is short, coarse and weak, thus submissive to hand spinning. Of the colour cottons cultivated, brown and green are the most common ones. The recent investigations in brown cottons highlighted various positive features like higher lint yield, acceptable fibre quality, spinnability, colour stability, enhancement of single yarn strength and pigmentation on scouring and mercerization. These inventions further expanded the utility and application of colour linted cotton for bed linen, furnishings and other variegated consumer goods as well as household textiles. Thus, naturally colour linted cotton forms the basic raw material to the handloom sector because of its fibre length, which is ultimately spun into coarser and uneven yarns. Further, naturally colour linted cotton may be blended with other natural and manmade fibres to produce blended and union fabrics. The utilization of these colour cotton yarns in producing blended and union fabrics are ecofriendly, since it avoids artificial dyeing that avert the contamination of environment, pollution and health hazards.

Cotton in its pure form and with blends is the principal textile fibre of the universe and is one of the world’s most socially vital and economically important agricultural cash crops. Millions of people depend on cotton cultivation because it meets the basic necessity of mankind and is known for its diversity, enormous utility, applicability, economic viability and advantageous properties. Of the 35 m ha of land used for cotton cultivation globally, only 0.02 % is used for cultivation of coloured cotton. Besides sustaining the country’s textile industry, it earns precious foreign exchange by way of export both yarn as well as finished goods. Further, more cultivation of naturally colour linted cotton on commercial scale not only forms an income generating activity for cotton cultivators, but also a source of livelihood for local spinners and weavers, thus positively supports the

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socioeconomic status of the handloom weavers, the neglected sector of the weavers community.

Naturally colour linted cotton can be blended with synthetic fibres to overcome the undesirable and to impart desirable properties in the spun yarn, which is short to produce the blended and union fabrics. Since ages, these blended and union fabrics are popular as blending is more likely to produce results superior to those obtained from single fibre alone. The handspun naturally colour linted cotton yarn with unequal distribution of slubs and snarls in the yarn give a fancy appearance and texture to the ultimate fabric that can go as designer’s fabrics. Thus, to produce unique and ecofriendly fabrics economically, an effort is made to interweave naturally coloured cotton with white cotton and filature silk (Muga, Mulberry and Tasar) to produce union fabrics in order to assess their performance by Kawabata Evaluation System.

Methodology

Two brown varieties of naturally colour linted cotton, viz. Dharwad Desi Coloured Cotton–(DDCC-1) and Dharwad Brown Hirsutum–250 (DBH–250), procured from Agricultural Research Station, Dharwad farm, Dharwad were hand spun, scoured and sized, and were used as weft with white cotton and filature silk (Muga, Mulberry and Tasar) to produce union fabrics. The detail on fabric information is given (Table 1). A total of 8 union fabrics with 4 control samples were used to assess the low stress mechanical properties using Kawabata Evaluation System - Fabric (KES-FB) system. From the low stress mechanical properties, the fabrics were rated for Primary Hand Value (HV) and Total Hand Value (THV) in order to evaluate the suitability of the fabrics for women’s winter thin dress and women’s winter suit.

Results and discussion

Fabric handle is a terminology expressing the character and quality of a fabric as manifested by its performance in respect of fitting to human body, the feel of the surface and comfort in wearing. The Kawabata system measures the properties of textile fabrics and predicts the aesthetic qualities perceived by human touch. The KES–FB includes 5 highly sensitive instruments that measure fabric bending, shearing, tensile, compression as well as smoothness and the frictional surface properties of a fabric. In other words the KES–FB objectively measures the hand properties, i.e. the instruments measure mechanical properties that correspond to the fundamental deformation of fabrics in hand manipulation. In absence of touch and feel by hand, the mechanical properties are measured and translated into Primary Hand Value (HV) and Total Hand Value (THV) to know the fabrics suitability. The low stress mechanical properties of the fabric were measured by KES-FB system in standard atmosphere of 65% RH and 27°C (Table 2).

Tensile test measures the stress / strain parameters at the maximum load set for the material being tested (0% - completely inelastic and 100% -completely elastic). Among the control samples, the fabric extensibility (EMT %) was found to be higher in White cotton (WC, 7.19%) followed by in Tasar (TA, 4.19%). Of the union fabrics, Muga X DBH-250 (MUD2, 7.86%) possessed higher extensibility followed by White cotton X DBH-250 (WCD2, 7.59%) and the lowest in Mulberry X DBH-250 (MBD2, 5.54%) fabric. Higher values indicated a stretchable material. However, fabric extensibility of union fabrics was higher compared to their respective control samples which revealed that union fabrics were more elastic than control samples. The tensile linearity (LT) is greater for Mulberry (MB, 0.849) control fabric followed by in Mulberry X DBH-250 (MBD2, 0.784) and Muga (MU, 0.78) control fabrics and was lower for White cotton (control) and union fabrics. The higher value of LT indicated greater linearity. Thus, filature silk fabrics have higher tenacity than white cotton fabrics. Tensile energy (WT, gf/cm/cm²) was greater in White cotton (control) sample (11.99 gf/cm/cm²) than filature silk control samples. However, among the union fabrics, the greater value was observed in Muga X DBH-250 (MUD2, 14.77 gf/cm/cm²) followed by in Muga X DDCC-1 (MUD1, 13.15 gf/cm/cm²), Tasar X DDCC-1 (TAD1, 12.34 gf/cm/cm²) and White cotton X DBH-250 (WCD2, 11.63 gf/cm/cm²). However, the tensile energy was greater in union fabrics than their respective control samples which revealed union fabrics to be stretchable and elastic in their tensile deformation than their respective control samples.

The tensile resiliency (RT %) indicates the recovery of deformation from strain or ability to recover from stretching. It was found that, the tensile resiliency (RT %) was greater in filature silk control samples (MU-70.26 %, MB- 60.54 % and TA-57.91%) than White cotton control sample (WC–44.94 %). However, among the union fabrics the
RT% was higher in *Tasar* X DBH-250 (TAD$_2$, 48.25%), *Muga* X DBH-250 (MUD$_2$, 45.90) and White cotton X DBH-250 (WCD$_2$, 45.25%). This revealed that the control samples had greater recovery from having been stretched than union fabrics and also among DDCC-1 and DBH-250 interwoven fabrics, DBH-250 interwoven fabrics had greater recovery from having been stretched.

Bending is a measure of force required to bend the fabric approximately 150°. The bending rigidity (B) and Hysteresis of bending (2HB) was higher in filature silk control and union fabrics thus indicated that these fabrics had greater stiffness / resistance to bending motions compared to White cotton control and union fabrics (Table 2). The higher value of B and 2HB was found in Mulberry (MB, 0.157...
gf/cm/cm) and White cotton (WC, 0.061 gf/cm/cm), respectively among control fabrics and Muga X DDCC-1 (MUD₁, B-0.26 gf/cm/cm, 2HB - 0.198 gf/cm/cm) among union fabrics. Hence, DDCC-1 interlaced fabrics are stiffer or resistance to bending motions compared to DBH-250 shot fabrics. Shear stiffness is the ease with which the fibres slide against each other resulting in soft / pliable to stiff / rigid structures. It is found that the shear stiffness (G) and Hysteresis of stiffness (2HG) was higher in White cotton control sample (0.95 gf/c.deg. and 2.33 gf/cm) compared to filature silk control fabrics. However, White cotton X DDCC-1 (WCD₁), Muga X DDCC-1 (MUD₁), Mulberry X DBH-250 (MBD₂) and Tasar X DBH-250 (TAD₂) showed higher values of shear stiffness and Hysteresis of stiffness. This may be due to the compact structure of the fabric and higher flexural rigidity.

The linearity of compression (LC) curve was found to be higher in Muga (MU, 0.434) followed by in White cotton (WC, 0.29) control fabrics while the lower value was observed in Tasar (TA, 0.236). Among the union fabrics, higher values of LC was observed in Mulberry X DDCC-1 (MBD₁, 0.404) followed by Tasar X DDCC-1 (TAD₁, 0.368) fabric. However, the compressional resilience (RC %) was higher in control fabrics than their corresponding union fabrics that indicated high per cent recovery from being compressed. The co-efficient of friction (MIU) was higher in union fabrics compared to their respective control samples which revealed that union fabrics had more contact area with that of body. Also higher MIU value corresponds to greater friction or resistance and drag. However, White cotton X DDCC-1 (WCD₁, 0.228), White cotton X DBH-250 (WCD₂, 0.225) and Mulberry X DDCC-1 (MBD₁, 0.201) possessed higher values of MIU. It was further observed that geometrical roughness (SMD) was higher in union fabrics than their respective control samples, i.e. higher SMD corresponds to geometrically rougher surface. However, the higher SMD was noticed in Tasar X DDCC-1 (TAD₁, 18.76) followed by in Muga X DDCC-1 (MUD₁, 17.004µm) fabric.

Further, these low stress mechanical properties were translated into Primary Hand Values (HV) and to the Total Hand Values (THV) to characterize these union fabrics for women’s winter thin dress and women’s winter suit. The Primary Hands used to characterize women’s winter thin dress were Koshi (stiffness), Numeri (smoothness) and Fukurami (fullness and softness), whereas the Primary Hands used to characterize women’s winter suit were Koshi (stiffness), Numeri (smoothness), Fukurami (fullness and softness) and Sofutosa (softness). These Primary Hands are rated numerically on a scale from 0 (weak) to 10 (strong) and the Total Hand Value is rated from 1 (poor) to 5 (excellent). Primary Hand and Total Hand Values of the fabric samples for women’s winter thin dress and reveals that, all the fabrics were rated above 5 for Koshi (stiffness) indicating that these fabrics are medium to strongly stiffer (Table 3, Fig. 1). However, higher value of Koshi was observed in Muga X DDCC-1 (MUD₁, 7.05) fabric followed by Tasar X DDCC-1 (TAD₁, 6.76) fabric. Among the control fabrics, Mulberry (MB, 6.56) showed higher value of Koshi (stiffness). The Numeri (smoothness) value was found to be higher in Tasar (TA, 6.95) followed by in Muga (MU, 6.21) fabric. Fukurami (fullness and softness) was higher in Tasar (TA, 9.68) control fabric and White cotton X DDCC-1 (WCD₁, 9.24) fabric. However, the rated values were above 6 for Fukurami revealing that these fabrics are medium to strong in fullness and softness. It is found from this table that, Koshi was found to be higher in DDCC-1 interwoven fabric, whereas lower in Numeri and Fukurami revealing that these fabrics are stiffer than DBH-250 shot fabrics.

The Total Hand Value (THV) among control fabrics was rated higher for Tasar (TA, 4.73) fabric followed by for White cotton (WC, 4.25) and Muga (MU, 4.18) fabrics. Among union fabrics, Mulberry X DDCC-1 (MBD₁, 4.05) followed by White cotton X DDCC-1 (WCD₁, 3.98) and White cotton X DBH-250 (WCD₂, 3.97) were rated higher values thus proving that these fabrics are excellent for women’s winter thin dress. However, the Total H and Values were

![Fig. 1—HV and THV for women’s winter thin dress](image-url)
above 3 for rest of the union fabrics except in Tasar X DDCC-1 (TAD1, 2.84). Table 4 & Fig. 2 show the Primary Hand and Total Hand Values of the fabric samples for women’s winter suit and revealed that the higher values of Koshi (Stiffness) among union fabrics was noticed in Tasar X DDCC-1 (TAD1, 5.37) followed by Mulberry X DBH-250 (MBD2, 5.06) and Mulberry control (MB, 5.18) which indicated that these fabrics were medium to strongly stiffer. In rest of all the control and union fabrics the values of Koshi was found to be below 5 indicated that these fabrics are fairly stiff. The values of Numeri (smoothness) and Sofutosa (softness) were found to be below 4 and Fukurami (fullness and softness) below 5 which revealed that these fabrics are slightly smooth and soft as well as medium in fullness and softness respectively for women’s winter suit. It is observed from this table that, Koshi, Numeri and Fukurami was found to be higher in DDCC-1 interwoven fabric than DBH-250 shot fabrics. The Total Hand Value (THV) among control fabrics was rated higher for Tasar (TA, 2.61) fabric followed by for White cotton (WC, 2.44) and Muga (MU, 2.42) fabric. Among union fabrics, Mulberry X DDCC-1 (MBD1, 2.53) followed by White cotton X DDCC-1 (WCD1, 2.48) and Muga X DDCC-1 (MUD1, 2.43) were rated higher values. However, the Total Hand Values were below 3 revealing that these fabrics are fairly suitable for women’s winter suit.

**Conclusion**

Generally colour linted cotton is short staple, with low fibre strength compared to white cotton. Hence, it may be difficult to spin the colour cotton to finer counts to produce quality yarn with absolute uniformity. The handspun yarn showed unequal distribution of slubs and snarls, an added advantage of fancy appearance and texture of handloom fabric. Further, the naturally colour linted cotton yarn with these unique properties alone may not add strength. Thus, suitable as weft to produce varieties of union fabrics on handloom with other suitable natural and
manmade yarns that add lustre, texture, smoothness, softness, strength and prevent shrinkage. Such newly woven union fabrics being new and unique of its kind are suitable for shirtings, dress materials, veils, scarves, furnishings and also can go as a designer’s fabric that definitely meets the fashion trends and sustain in both domestic and international market as well as support the handloom sector.

Implication

References