ABSTRACT

The present investigation encompasses studies conducted on the effect of chemical treatment of milkweed fibres (pergularia daemia), its blend proportion and spinning systems on quality of cotton/milkweed (C/M) blended yarns. The cotton fibres were blended with raw, alkali treated and dyed milkweed fibres respectively at three different blend proportions such as 80/20, 60/40 and 40/60 to analyze the spinnability and quality of the yarns in ring, compact and rotor spinning systems. The optimization of process parameters in ring and rotor spinning was done using factorial and Box-Behnken design systems. The yarn structural studies such as fibre migration, yarn packing density and migration index were done for cotton/milkweed blends to correlate the yarn structure and yarn characteristics. The comparison of 100% cotton and cotton/milkweed 60/40 bended rotor yarn fabrics were made to rationalize the application of cotton/milkweed blended fabrics.

To improve the spinnability of milkweed fibres, alkali treatment and dyeing of fibres were carried out and their morphological, physical, chemical and thermal properties of fibres were analyzed. The physical properties of milkweed fibres were comparable to that of cotton except for fibre elongation and short fibre content. The chemical composition of *pergularia daemia* milkweed fibre is similar to those of common milkweed fibre (*asclepias syriaca*) with low cellulose percentage and high lignin

content. The raw milkweed fibres showed smooth, rod like surface but the surface becomes rough after the chemical treatments. In addition, the alkali treated fibres showed few convolutions due to collapse of hollowness. The fibre-to-fibre friction increases after the chemical treatments, due to changes in the fibre surface geometry. The crystalline percentage of raw and chemical treated milkweed fibres are found to be around 56%, which is lesser compared to cotton fibres, 92%. The thermal stability of milkweed fibres are improved after the chemical treatments, but is still lower compared to cotton fibres. The alkali treatment of milkweed fibres showed overall improvement in fibre properties especially in fibre friction and elongation-at-break and improvement in the spinnability of milkweed fibres.

The effect of chemical treatment of milkweed fibres and its blend proportion and spinning systems on quality of C/M blended yarns were analyzed. In general, the rotor spun yarns showed better yarn characteristics except yarn tenacity irrespective of chemical treatment and milkweed proportion. The lesser spinning tension, back doubling and individualization of fibres with opening rollers in rotor spinning results in better rotor yarn characteristics. The compact spun yarns showed better results in terms of yarn tenacity and hairiness compared to ring spun yarns due to the elimination of spinning triangle, but no significant improvement was noticed in yarn evenness and imperfections. The alkali treated milkweed fibre blended yarns

showed better results followed by dyed and raw milkweed fibre blended yarns irrespective of spinning systems.

Considering the effect of chemical treatments and milkweed percentage on yarn characteristics, the alkali treated milkweed fibres at C/M 60/40 was considered for further optimization in ring and rotor spinning systems. In ring spinning, the process parameters such as roving twist multiplier (TM), break draft and break draft zone setting that influence the drafting force were considered for optimization using full factorial design. From the yarn results, the roving TM of 1.3, break draft zone setting of 60 mm and break draft of 1.18 were considered to be the optimized values. These values were used for further production of milkweed blended yarns for the optimization of fibre friction, front zone roller setting and front top roller load both in speed frame and ring frame. From the yarn characteristics, it was observed that higher inter-fibre friction, higher top roller load and medium roller setting gives optimum results in speed frame and ring frame. In case of rotor spinning, fibre friction, opening roller speed and sliver linear density have been considered for optimization. From the results it was observed that higher inter-fibre friction, average opening roller speed of 6010 rpm and 3.54 g/m sliver linear density provided better yarn characteristics.

A study was also conducted to explore the relationship between yarn structure and yarn characteristics of C/M blended yarns. The difference

between theoretical and actual number of fibres in yarn cross-section increases with the increase in milkweed percentage in blend due to fibre losses in carding and fibre flies during drafting in the succeeding processes. The fibre migration index values revealed that the milkweed fibres are predominantly in the yarn sheath of C/M 80/20 yarns whereas it occupies the yarn core in C/M 60/40 and 40/60 as small clusters due to its higher initial modulus and lower fineness compared to cotton. Fibre migration studies revealed that the compact spun yarn have higher fibre migration factor, which is responsible for its higher tenacity followed by ring and rotor spun yarns. The effective packing density of C/M blended yarn decreases with increase in milkweed blend proportion due to less cohesiveness and poor self locking structure of milkweed fibres in the yarn cross-section.

The woven fabric produced from C/M 60/40 rotor blended yarn showed better drapeability, lower thermal conductivity and better wicking property compared to 100% cotton fabrics. Cultivation methods and the use of hybrid seeds will improve the yield of milkweed floss. The milkweed blended fabrics could be used in apparel, where better thermal insulation with lower fabric weight along with drapeability is required.