STUDIES ON UNCONVENTIONAL CHIENGORA FIBRES AND ITS BLENDS FOR TEXTILE APPLICATIONS

ABSTRACT

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SURJIT R

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ANNA UNIVERSITY

CHENNAI 600 025

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ABSTRACT

The population is increasing rapidly in the world and there will be a steady increase in the demand of textile fibre consumption to cover market needs world-wide. Chiengora fibres can be an additional source for the future needs. The study is concerned with the characterization of chiengora fibres from hairs of five different dog breeds, analysis of spinnability and production of knitted and nonwoven fabrics of chiengora fibre blends to deduce usability of chiengora fibres.

The fibres are characterized to understand their properties. The chiengora fibres from five different breeds of dog namely labrador, golden retriever, german shepherd, pomeranian and lhasa apso have been characterized for their physical, chemical, morphological and thermal properties thereby leading to selection of two breeds for spinning yarn. The study reveals that the chemical, morphological and thermal properties of the hairs of five breeds are similar to each other. However marked difference is observed in the physical properties of the fibres like denier and diameter. These fibres comprise of protein ranging from 45% to 55% with golden retriever having the highest amount of keratin. The moisture content ranges between 9.9% (Labrador retriever) and 12.3% (German shepherd). The wax content of chiengora fibres is highest for Lhasa apso hair fibre at 33.4% and lowest for golden retriever at 12%. The wax content is inversely proportional to the diameter of the fibre as lhasa apso hair fibre has a diameter of 28.83 µm with a wax content of 33.4% whereas golden retriever has a diameter of 65.04 µm with a wax content of 12%. The chiengora fibres have less resistance to alkalis and completely dissolve in sodium hypochlorite. These fibres are resistant to dilute acids but fibre damage occurs when treated with concentrated acids. Lhasa apso hair fibre and pomeranian hair fibre have the lowest denier of 5.5 and 8.23 in comparison with hairs of other breeds. It is

also found that chiengora fibres have more tenacity than other animal fibres with lhasa apso having higher tenacity at 2.22 g/denier which is higher than the strongest camel fibre (1.79 g/denier). Also the elongation of chiengora fibres is observed at 43.7% similar to elongation of wool at 47%. The IR spectroscopy results show common absorptions around 3751, 3675, 3649, 2917, 2849 and 1650 cm^{-1} indicating amide I and amide II absorptions which are typical characteristics of any protein fibre. The XRD results reveal that chiengora fibres are having crystallinity between 29.19% and 33.42% which is higher compared to other animal fibres. Scanning electron microscopy studies show prominent scales on the surface in the longitudinal view of the hairs of all the breeds. The morphological studies showed higher number of scales on the surface of chiengora fibre which leads to better thermal insulation. It is also found that these fibres are similar to wool and other animal fibres that are available. Thermogravimetric (TG) analysis of chiengora fibres shows two main weight loss intervals. The first loss between 30˚C to 110˚C is due to water loss and second loss between 200˚C to 450˚C is from thermal degradations such as carbonation, fusion and decomposed air-state release. TG curves indicate that these fibres are stable up to 220˚C and hence can be utilized for applications less than 220˚C without any change in its properties. Differential scanning calorimetry (DSC) curves of chiengora fibres showed two endothermic peaks at around 220-225˚C and 310-330˚C which may be due to chiengora inner crystal splitting decomposition and breakage of chiengora intermolecular chemical bonds respectively. DSC curves corroborate with TG curves showing that the fibres are not degraded between 30˚C to 200˚C. However it does exhibit changes between 200˚C and 600˚C. These fibres will provide better thermal insulation properties than other fibres as observed through the morphological and thermal studies carried out on these hairs. Only hairs of lhasa apso and pomeranian breed have good machine spinnable characteristics due to their finer denier and

higher slenderness ratio and can be machine spun into yarn to create textile products.

The chiengora fibres from lhasa apso (L) and pomeranian (POM) are made into yarns based on their comparatively better properties in association with polyester (P) and acrylic (A) and their yarn characteristics were evaluated. The chiengora yarn and its blends are compared with wool (W) yarn and its blends and the results are presented in this chapter. Open end spinning is used for producing yarns. Yarns in twenty three blend proportions are produced and their properties are compared. Lhasa apso, pomeranian hair fibres and wool fibres are blended with polyester and acrylic separately. The blend proportions are as follows: 100L, 100P, 100POM, 100A, 100W, 75/25 L/P, 75/25L/A, 75/25POM/P, 75/25POM/A, 75/25W/P, 75/25W/A, 50/50L/P, 50/50L/A, 50/50POM/P, 50/50POM/A, 50/50W/P, 50/50W/A, 25/75L/P, 25/75L/A, 25/75POM/L, 25/75POM/A, 25/75W/P, 25/75W/A. The fibre loss in carding and sliver breakages was higher for 100% chiengora yarns spinning. The actual blend proportions matched with mixing blend proportions closely when the chiengora content (25%) was least in the blended yarns. The evenness properties, strength, elongation of all these yarns are compared and statistical significance is analysed using ANOVA (Analysis of variance). The count of all these yarns were maintained as 14s Ne. Also the twist per inch (TPI) was maintained around 16. The yarn irregularity (U%) of the yarn blends show that increase in chiengora content is increasing the U% with 100% pomeranian and 100% lhasa apso yarn having U% of 21.6 and 18.44 respectively similar to 100% wool having a U% of 21.81. ANOVA shows that there is significant difference between U% of different blend proportions of each group of yarn (Lhasa apso/Polyester, Lhasa apso/Acrylic (A), Pomeranian/Polyester, Pomeranian/Acrylic, Wool/Polyester, and Wool/Acrylic). Similarly strength of the yarns reduce with increase in chiengora and wool content with highest strength obtained for 25/75 lhasa

apso polyester at 12.39 gram/tex and lowest for 100% wool at 5.86 gram/tex. ANOVA shows similar significant difference in yarns as in the case of U%. The elongation percentage of yarns increases with chiengora and wool content with 100% wool having an elongation of 13.4% and 100% lhasa apso with 12.97%. Similar significant difference in elongation is noted as in the case of U%. The hairiness of the 100% chiengora and wool yarns are found to be on the higher side at 10.5 for 100% pomeranian, 10.28 for 100% lhasa apso and 10.36 for 100% wool. From the analysis of yarn properties of chiengora, wool and its blended yarns, it is observed that all the yarn properties deteriorate with increase in chiengora and wool content. This may be due to the coarser nature of the animal fibres making them protrude on the surface rather than getting bound in the yarn. Significant difference is observed in the case of hairiness similar to U%. The thin places, thick places, neps, total imperfections are also more for higher percentages of chiengora and wool and are statistically significant between blends. The yarn characteristics of chiengora fibres are observed to be similar to wool. However the yarn quality index (YQI) of 75/25 and 50/50 lhasa apso polyester were found to be better indicating their suitability for further usage. However all the blended yarns are converted to knitted fabrics to identify if fabric properties will also be similar to wool especially the thermal insulation as it may help us in deciding proper usage of the chiengora fibres.

The chiengora yarns are knitted to fabrics and the properties of these fabrics are ascertained and compared with the properties of developed knitted wool fabrics and its blends. The results of the knitted fabric characteristics are presented in this chapter. The 2X2 rib fabrics were knitted in 23 different blend proportions of yarns developed and their fabric properties were tested. It was found that the bursting strength of yarns decreased with increase in chiengora content similar to wool fibre fabrics. The air permeability, wickability and water vapour permeability were found

to be lesser for 100% chiengora fabrics similar to the characteristics exhibited by woollen fabrics. It is found that the chiengora fabrics possessed higher thermal insulation property. It is found that the 100% lhasa apso fabrics has thermal insulation value (TIV) of 0.606 clo which is 38% more than the 100% wool fabric which has 0.373 clo thereby confirming that these fabrics can be used for thermal wears like sweaters. The presence of scales and thermal properties indicate better thermal insulation properties for these chiengora fibre fabrics. The 75/25 lhasa apso polyester fabrics can be considered as the better blend proportion than other produced fabrics due to their better yarn properties, comfort properties and higher TIV than wool. However the end use for all the produced chiengora blended fabrics is given based on the TIV.

The chiengora fibre (Lhasa apso) nonwovens and its blends are developed and their properties are measured. Their properties are compared with developed woollen nonwovens and their blends and the results are presented in this chapter. The chiengora fibres were made into nonwoven fabrics by blending with polyester fibres at different proportions for its better strength, thermal insulation behaviour and cost effectiveness. Hair of Lhasa apso breed dog was chosen to blend with polyester based on its comparative finer denier of 5.5 and high tenacity value to produce the nonwoven fabrics. Out of the developed nonwoven fabric, the 100% chiengora fibre fabric had more thickness and the thickness values ranged from 2.8 to 3.2 mm for all fabrics. The highest bulk density of 0.143 g/cm^3 is noted for 50 /50 chiengora polyester fabric. The 30/70 chiengora polyester nonwoven fabric had higher tear strength of 46 N. The chiengora and its blends are found to have higher tear strength than wool. The higher air permeability value of 74 and 70 $cm^3/s/cm^2$ is noted for 100% polyester fibre fabric and 30/70 chiengora polyester fabrics respectively. The 100% chiengora nonwoven fabric had thermal insulation value of 1.195 clo which was higher than that of 100%

wool fabric by 42%. The 100% wool nonwoven fabric had thermal insulation value of 0.688 clo which was also lower than 70/30 chiengora polyester fabric with 0.800 clo. The chiengora nonwoven fabrics also possessed similar sound insulation properties when compared with wool with both 100% chiengora and 100% wool fabrics having similar noise reduction coefficient (NRC) of 0.23 and 0.22 respectively. The 70/30 polyester fabric (with NRC value of 0.20) can also be used as an alternative to wool in a smaller scale thereby reducing the consumption of wool and the cost by utilizing the chiengora fibre which is thrown as a waste in many countries. The research findings indicate that the chiengora fabrics can be used for thermal and sound insulation purpose effectively for textile and industrial applications.

The studies indicate that chiengora fibres need not be discarded as a waste and can be effectively utilized as thermal wears. The nonwovens can be used as padding material for thermal and acoustic insulation applications related to industries. They can also be used as padding material in clothing for cold protection. These fibres can be an additional fibre along with wool and other animal fibres as they have better insulation properties and also they need not be thrown as waste. These fibres can also be blended with polyester and acrylic to create many textile products commercially.