Abstract

Development of functional textiles (mosquito repellent, antibacterial, UV-protective, and flame retardant) using novel routes is highly demanded. Mosquito-borne diseases are a great concern for human health, and an increment in urbanisation is causing a rise in the population of mosquitoes. Efficient methods and products for preventing mosquito bites are the urgent need of the hour. To protect against mosquitoes, mosquito-repellent textile is an attractive option. Dyes provide an attractive appearance to a textile substrate, and functional dyes can impart functional properties to textile substrates, thereby eliminating textile finishing process. The present work explores the synthesis and application of novel functional dyes for imparting functional properties, such as mosquito repellency, antibacterial activity, UV protection, and flame retardancy to textile materials.

In the first part of this research, the preparation of a mosquito repellent-cum-UV-protective nylon using a novel reactive dye was attempted. The synthesis of dye involves the reaction of cyanuric chloride with H-acid (4-Amino-5-hydroxy-2,7-naphthalenedisulfonic acid) to generate cyanuric-H-acid, which was further reacted with diazotised 4-amino-N, N-diethyl-3-methylbenzamide (DEET-NH_2) to synthesise a novel cold brand reactive dye. Functional properties (mosquito repellency and UV protection) of dyed nylon and its durability against the laundering treatments were evaluated. An outstanding mosquito repellency (100%) and a good UV protection were achieved on dyed nylon.

In the second part of this research, a novel disperse dye based on diazotised sulfadiazine, and 4-hydroxy coumarin was developed. The dyeing of polyester with the synthesised disperse dye was performed. The exhaustion (%), fixation (%), and colouration properties (L*, a*, b*, K/S) were studied. The disperse dye imparted excellent UV protection, good antibacterial activity (>68%), and outstanding mosquito repellency (100%).

In the third part of this research, the synthesis of a new acid dye to develop mosquito-repellent and UV-protective nylon was attempted. The acid dye was synthesised by reacting a diazotised derivative of ethyl anthranilate with H-acid. The acid dye was utilised for the dyeing of nylon, and dyeing characteristics (exhaustion and fixation) were examined. The dyed fabrics were imparted with 100% mosquito repellency and excellent UV protection.

In the fourth part of this research, a cationic (basic) dye was developed. The reaction of mosquito repellent (diazotized ethyl anthranilate) with imidazole generated an azo dye, which was further quaternised to make a cationic dye. Acrylic fibre dyed with the synthesised dye

was evaluated for fastness and functional properties. The dye's colouration properties, such as exhaustion and fixation, were also determined. The dyed fabric showed multifunctional properties (mosquito repellency of 100% and excellent UV protection), which were retained to a significant extent even after laundering treatments.

In the fifth part of this research, an aromatic amine (4,4'-(1,4-phenylenebis(1,3,4-oxadiazole-5,2-diyl)) dianiline) was prepared from the polyester bottle waste. A new acid dye was developed on wool using the *in-situ* dyeing method by the reaction of the diazotised amine with H-acid. The evaluation of colouration and fastness properties of dyed wool was performed. The dyed wool was also studied for antibacterial and UV protection effects. An antibacterial activity of more than 70% and excellent UV protection were displayed by dyed wool.

In the sixth part of this research, an acid dye was developed to provide wash-durable flame-retardant protection to wool. A phosphorus and nitrogen-based compound containing multiple amino groups was synthesised. The amine was diazotised and reacted with H-acid to synthesise acid dye *in-situ* on wool fabric. The flame retardancy provided by dyed wool was determined using the limiting oxygen index (LOI), vertical flammability, and cone calorimetry analysis. The colour appearance, colour values, and fastness properties of dyed wool were evaluated to check the dyeing properties of the acid dye on wool fibre. The newly developed acid dye provided wash-durable colouration and flame-retardant effects to wool. A maximum LOI value of 35.5 was obtained, and the dyed wool displayed efficient flame retardancy.