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A COMPARISON OF THE TACTILE PROPERTIES AND THERMAL COMFORT CHARACTERISTICS OF ENZYME SCOURED AND CAUSTIC SCOURED FABRICS

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Abstract

The tactile properties and thermal comfort characteristics of a plain woven cotton fabric were compared. Fabric treatments representing greige state, conventional caustic scouring, and protease scouring were measured. Figures 1-5 compare the measured tactile properties of the fabrics. Figures 6 & 7 compare the air permeability and thermal energy dissipation characteristics of the same fabrics. The tactile characteristics were measured using the Kawabata equipment.

KES Test Methods

The major forces acting on a fabric when it is rubbed between fingers for subjective hand evaluation are bending, shear, compression and tensile forces. The instruments developed by Kawabata basically characterize fabric response to these forces under low stress conditions. The shape of the force-deformation curves and certain numerical values extracted from these curves characterize the response of the fabric under a given set of deformation and recovery conditions. The following paragraphs provide a brief description of the individual Kawabata tests and the parameters obtained from each test.

Tensile

Stress/strain curves are generated in a manner similar to those under high stress conditions except that the peak stress values are much less, being comparable to those encountered during the actual wearing of the garment. Test specimens 20 cm wide and 5 cm long (20cm by 5cm) are stressed between two sets of clamps until a peak load of 10 kg is imposed on the 20 cm wide sample (until a peak load of 500 grams per centimeter width of the fabric is imposed). The stress on the fabric is then gradually relieved by reversing the motion of the movable clamps (the movable clamps are allowed to go back to their original position). The parameters obtained from the tensile test are:

EMT%: percentage tensile elongation which is a ratio of the actual extension to the original sample length, expressed as a percentage,

WT: tensile energy or work done in tensile deformation represented by the area under the stress-strain curve,

WT': energy or work recovered as a result of relieving stress on the material, represented by the area under the recovery curve,

RT%: tensile resilience, which is the ratio of work recovered to the work done in tensile deformation, expressed as a percentage, 100(WT'/WT), and

LT: A measure that defines the extent of non-linearity of the stress/strain curve. LT values below indicate that the stress/strain curve falls below the straight line connecting the initial and final points of the stress-strain curve, while LT values greater than 1.0 indicate that the stress/strain curve falls above the straight line.

Shear

The shear test is carried out on the same instrument used to run the tensile test (the KES Tensile and Shear Tester performs both the tensile and shear tests, one at a time). As in the case of the tensile test, the fabric sample is mounted between two sets of clamps (forward and backward clamps) but the front set of clamps moves side ways to impose a shear stress on the fabric. The size of the test specimen used is again 20 cm by 5 cm. Starting from the initial position, the 20 cm wide fabric sample is first sheared 8 degrees to the right and then the horizontal shearing motion of the front clamps is reversed until they reach their original(zero shear angle position). The sample is again sheared 8 degrees to the left and then the shear motion is fully reversed as before. The shear test therefore permits the measurement of both shear modulus and shear hysteresis properties when the fabric is sheared in both directions. The physical parameters computed in the shear test are:

G: shear modulus (g/cm.degree), which is the slope of the shear curve, and

2HG: hysteresis width (g/cm) at a shear angle of 0.5 degrees

2HG: hysteresis width (g/cm) at a shear angle of 5 degrees

Compression

In the compression test, a standard area of the fabric 3.14 sq.cm)is subjected to a known compressive load (50 g/sq.cm)and then the load is gradually relieved. The load is applied through a movable plunger that moves up and down and compresses the fabric sample kept on a stationary platform. The following physical parameters characterize the compression and recovery behavior of the fabric:

TO: fabric thickness (mm) at a very low compressive load (0.5 g/sq.cm),

TM: fabric thickness (mm) at the maximum compressive load (50.0 g/sq.cm),

WC: work done in compression (g.cm/cm^2), represented by the area under the compression curve,

WC': work recovered as a result of relieving the load imposed on the fabric, represented by the area under the recovery curve,

RC%: compressive resilience, which is the ratio of work recovered to work done, expressed as a percentage, 100(Wc'/WC)

LC: linearity of the compression curve, which will have values similar to that of LT, and

EMC%: compressibility, which is the ratio of, measured reduction in thickness to the original fabric thickness, expressed as a percentage, 100(TO–TM)/TO.

Interpretation of KES Properties

Measured compression properties provide an excellent indication of the change in softness properties. In general, higher values for compression energy (WC) and % thickness compression (EMC%) coupled with lower values for compression linearity (LC) and compressive resilience (RC%) indicate improvement in fabric softness. Comparison of the measured compression properties indicates that both the treated fabrics are softer than the untreated fabric and that the improvement in softness of the protease treated fabric is as good as that of the caustic treated fabric.

Measured tensile and shear properties provide clues on flexibility, stiffness and softness properties. An increase in tensile elongation (EMT%) and tensile energy (WT), coupled with a decrease in tensile resilience are indicative of reduced stiffness and improved softness. It can be seen that both the treated fabrics demonstrate reduced stiffness and that protease treatment is as effective as caustic treatment in reducing fabric stiffness. Both treated fabrics also show an in increase in shear rigidity (G) and shear hysteresis properties. The change in shear properties also indicates better fabric softness, and it is clear that protease treatment produced nearly identical effect in terms of softness and stiffness changes as that of caustic treatment.

Interpretation of Heat Energy Dissipation and Air Permeability Properties

Both treatments contributed to a reduction in void space in the fabric as indicated by the reduced air permeability values and the increased values for the difference in heat energy dissipation, which in effect imply improved thermal insulation. Thus in terms of thermal comfort behavior also, protease treatment showed a very similar effect as that of caustic treatment.

Conclusions

1. Both caustic and protease scouring improve fabric softness, reduce fabric stiffness and increase shear rigidity.
2. Both caustic and protease scouring improve fabric thermal insulation properties.
3. Protease scouring has as good effect as caustic scouring on fabric KES properties and thermal insulation properties.

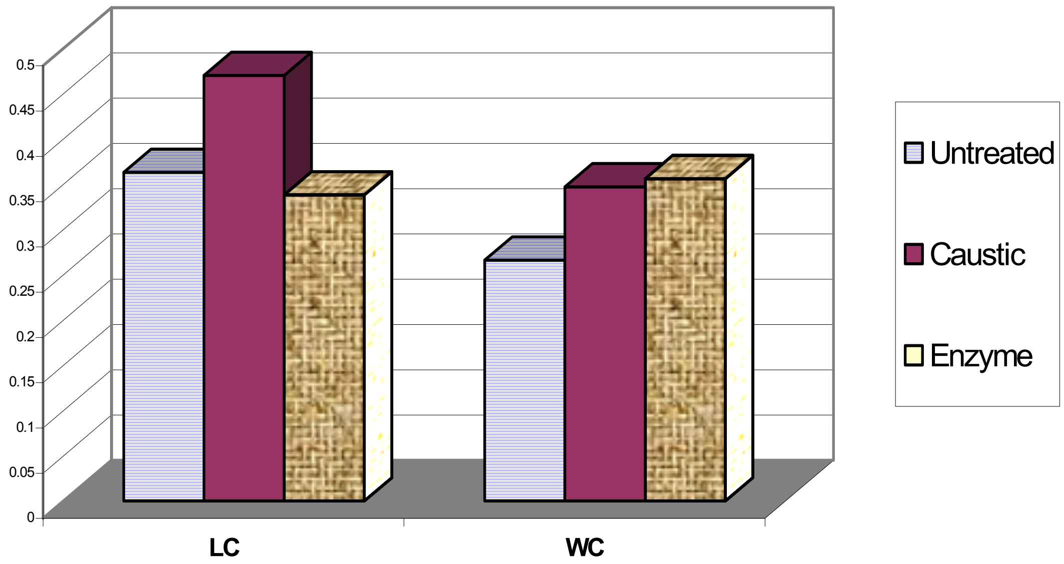

Figure 1. Comparison of Compression Properties (LC and WC).

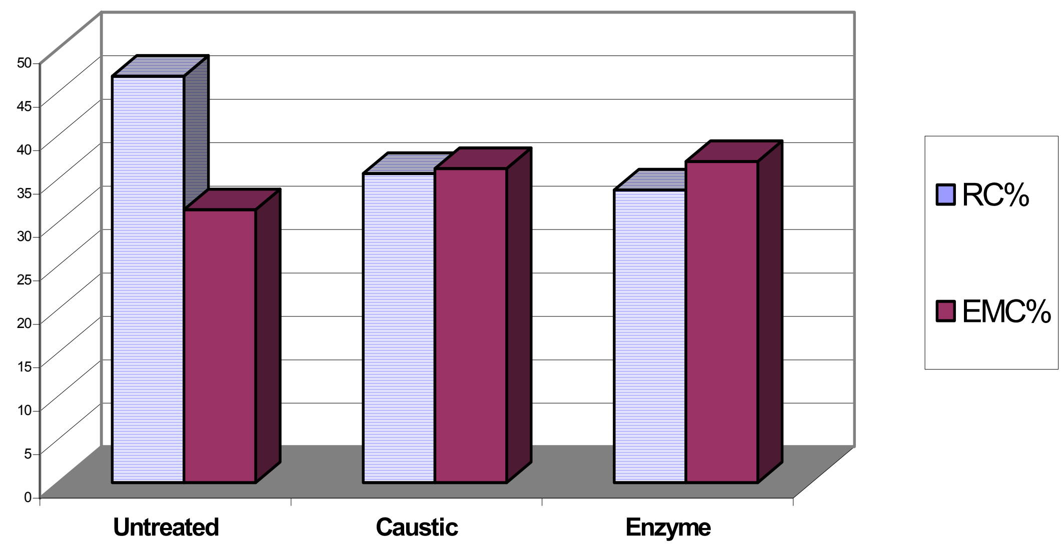

Figure 2. Comparison of Compression Properties (RC% and EMC%).

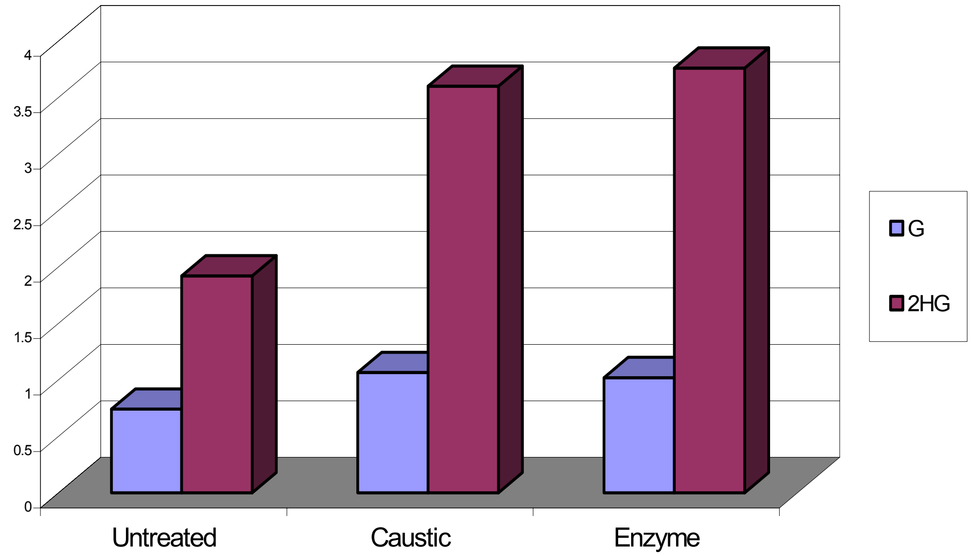

Figure 3. Comparison of Shear Properties (G and 2HG).

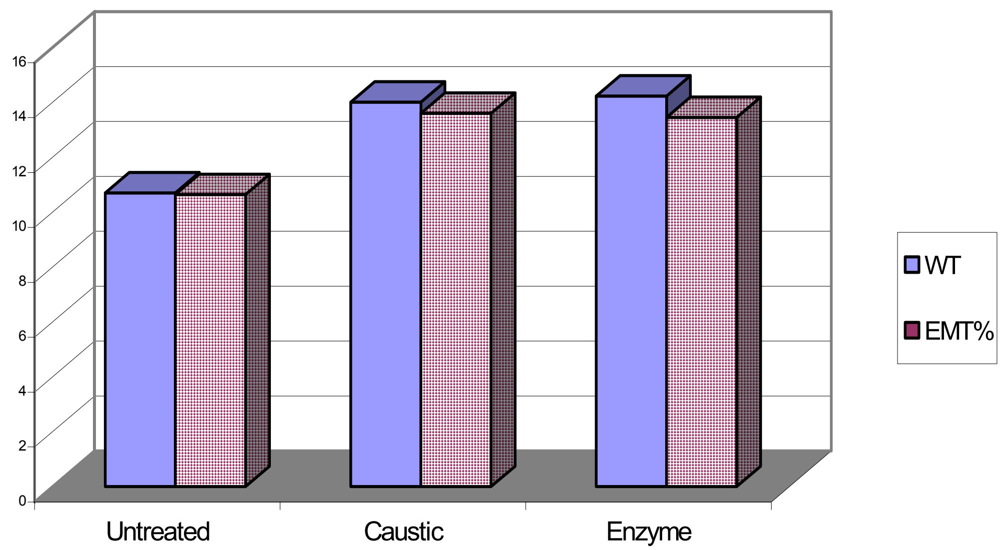

Figure 4. Comparison of Tensile Properties (RT% and EMT%).

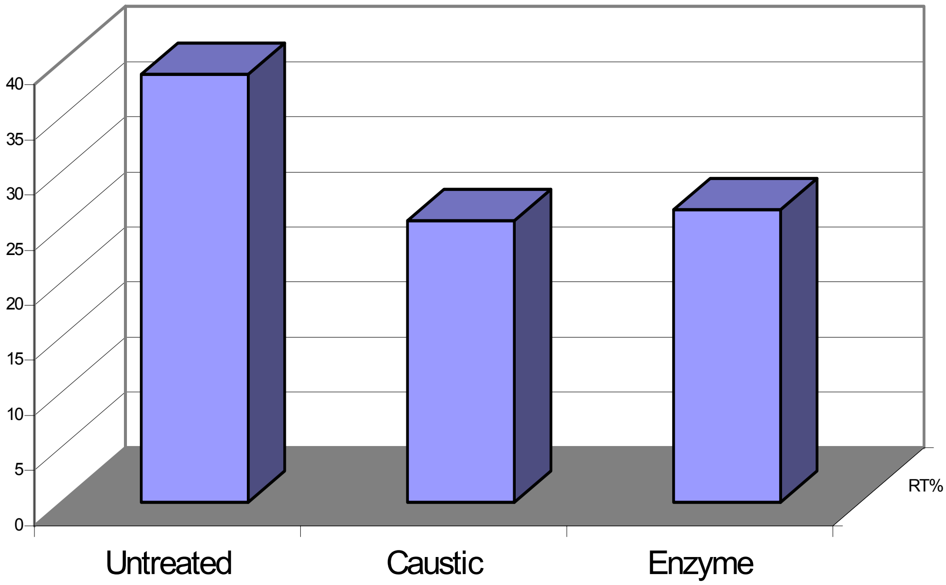

Figure 5. Comparison of Tensile Properties (RT%).

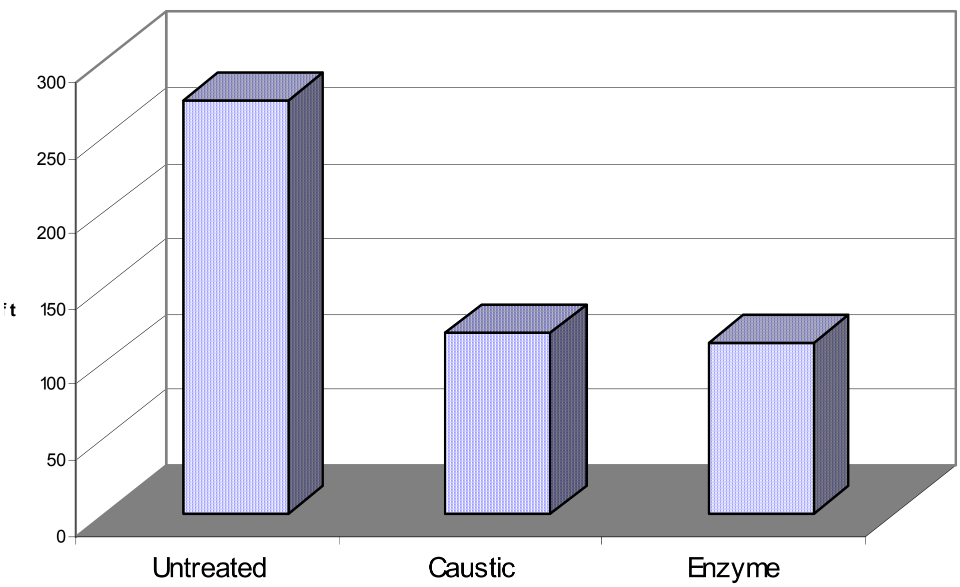

Figure 6. Comparison of Airpermeability Values.

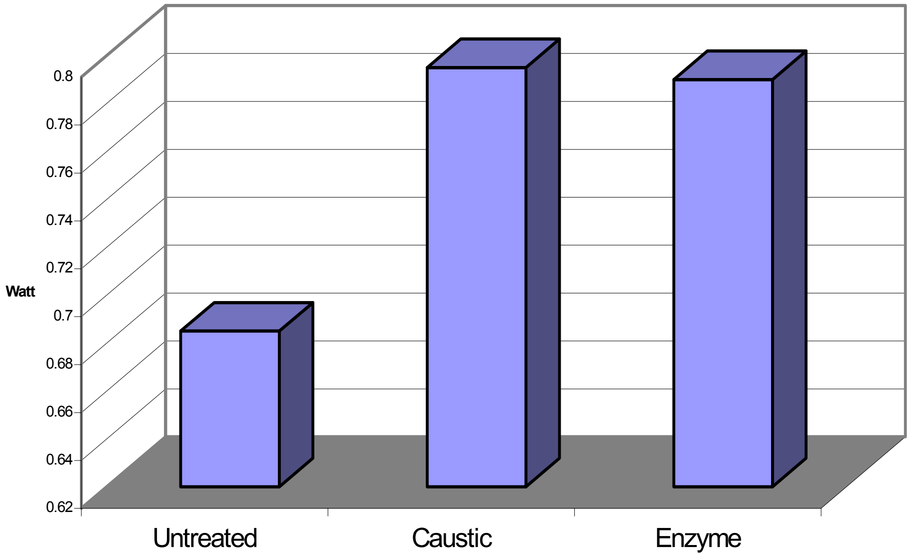

Figure 7. Difference in Heat Energy Dissipation Through Fabric.