

Moth Resistance of Glutaraldehyde-Stabilized Wool

March 5, 1968 *Biological Testing Procedure*

Dear Sir:

There has been considerable interest in our previous letter [1] concerning the stabilization of wool by glutaraldehyde [2]. The authors thought that tests on the insect-resistance of glutaraldehyde-modified wool would be of interest even though the results are negative. This letter reports quantitative data of feeding tests with larvae of the black carpet beetle.

Experimental

The wool for these studies was sheared from a scoured, pickled shearling, washed, neutralized with NaHCO_3 by the ASTM Standard Method of Test for Alkali-Solubility of Wool [3], washed, then air-dried at room temperature. A 20-g sample of wool was extracted with carbon tetrachloride by the above method to remove natural oils, then air-dried at room temperature for use as a control.

Glutaraldehyde modification of wool. Samples (20 g) of wool were modified with 10%, 20% and 40% glutaraldehyde (25% commercial solution), based on the air-dry weight, by the procedure described previously [1], washed, air-dried at room temperature, extracted with carbon tetrachloride by the above method [3], and air-dried. The amounts of glutaraldehyde combined were determined by analyses of the solutions by the iodometric method [4] before and after reaction with the wool.

Glutaraldehyde modification of wool cloth. White wool cloth was cut into two pieces. One piece was modified with 30% glutaraldehyde (25% commercial solution), based on the air-dry weight, by the above procedure. The glutaraldehyde-modified wool cloth showed an air-dry weight increase of 4.2%. The other piece served as a control.

Biological evaluations were conducted with larvae of the black carpet beetle *Attagenus megatoma* (Fabricius) (= *piceus*) according to the excrement weight and weight-loss test procedures established by CSMA [5]. Samples of the wool and wool cloth were exposed individually to 10 larvae for 14 days. The larvae were of a size that passed through a U. S. Standard Series No. 14 sieve and were retained on a No. 16 sieve. They weighed 6-7 mg each. The salve tins used as the test cages were 70 mm in diameter and 45 mm deep. They provided the larvae with the choice of staying on or off the test items.

One set of 4 samples of cloth 1 × 2 in. and samples of wool about 500 mg each were used for feeding tests; one set was used as controls for correcting loss or gain of weight due to humidity changes. Botany-style No. 315 woolen broadcloth containing 100% of wool, which is designated as the standard fabric for mothproofing tests by the AATCC [6] and the CSMA [5] was used as a control to check the feeding activity of the test larvae.

According to CSMA [5] specifications, a test is considered to show satisfactory resistance to carpet beetle larval feeding if an average quantity of excrement of not over 5 mg per sample (0.5 mg per larva) is produced during the 14-day exposure, provided no single specimen has more than 6 mg of excrement. The weight-loss specification considers the protection satisfactory when the average loss of weight due to insect feeding is not more than 8 mg, provided no individual treated sample has a loss greater than 10 mg. A test would be considered invalid if the quantity of excrement deposited on the control samples averaged less than 15 mg per sample (1.5 mg per larva), or if the amount of feeding resulted in less than a 30-mg average loss of weight per control

sample. A test would also be considered invalid if mortality was more than 10% among the larvae exposed to the untreated controls.

The results of the 14-day CSMA feedings tests conducted with black carpet beetle larvae on samples of glutaraldehyde-modified wool and wool cloth are given in Table I.

TABLE I. Biological Data Obtained After Exposing Glutaraldehyde-Modified Wool to Carpet Beetle Larvae

Sample	Glutaraldehyde (100%)		Adjusted weight loss† mg.	Excrement per larva mg.	Mortality† %
	Added* %	Combined* %			
Wool	0	0	48.79	2.08	0
Wool	2.5	1.9	69.02	2.36	0
Wool	5.0	2.8	50.06	2.03	0
Wool	10.0	4.1	47.12	1.71	0
Wool cloth	0	0	41.07	2.28	0
Wool cloth	7.5	4.2	41.38	2.43	0
Botany cloth	0	0	36.70	1.79	0

* On air-dry weight.

† After 14-day exposures.

All of the biological evaluations were conducted in a darkened cabinet at a constant temperature of $26.6 \pm 1.1^\circ\text{C}$ and $60 \pm 5\%$ RH.

Discussion

None of the modifications satisfactorily protected the wool against larval feeding, as judged by the adjusted weight loss and excrement per larva. Glutaraldehyde-

modification appeared to increase the rate of feeding at the 1.9% level, but had only a slight effect on the rate at the maximum 4.1% concentration. There were no significant differences in adjusted weight loss and excrement per larva between the glutaraldehyde-modified wool cloth and the unmodified wool cloth. The zero mortality of the larvae in all tests indicates a low toxicity due to the chemical combination of the glutaraldehyde with wool keratin.

Literature Cited

1. Happich, W. F., Windus, W., and Naghski, J., *Textile Res. J.* 35, 850-852 (1965).
2. U. S. 3,342,543, Sept. 19, 1967.
3. American Society for Testing Materials. Book of ASTM Standards, Pt. 25, D1283-57 (1966).
4. Fein, M. L. and Harris, E. H., Jr., U. S. Dept. of Agri., Agricultural Research Service, ARS 73-37 (1962).
5. Chemical Specialties Manufacturers Association, Soap and Chemical Specialties Blue Book 42, 219-222 (1966).
6. American Association of Textile Chemists and Colorists, Technical Manual, B-166-B-170 (1966).

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