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Control of Fabric-Feeding Insects by neutralizing vitamins in fibers

Clothes moths and carpet beetle larvae—the fabric insects of most economic importance—are dependent for normal development upon vitamins contained in woolen fibers and certain vitamins within the B-complex.

Clean fibers do not have enough food value to support any fabric-feeding insect through a complete life cycle. However, the needed nutrients are readily accessible in contaminants added to fibers by handling or by absorption of urine, perspiration and body oils. The required vitamins are included in all kinds of stains from food and liquids. Even cigar and cigarette ashes yield traces of micronutrients that attract rather than repel clothes moth larvae. No fabric can be considered clean unless it is first sterilized and then quickly confined to some air-tight container. However, textiles are the most widely used commodity on the world market today and, as such, are constantly subject to insect attack.

Studies on bacterial and animal nutrition led to investigations of the vitamin needs of fabric-feeding insects and the possibilities of their control by the use of growth factor analogs—antimetabolites.

Antimetabolites resemble closely in chemical structure a vitamin or other growth substance, but by design are slightly altered in their manufacture. Perhaps a single atom has been omitted, or added where it does not belong. With such a chemical structure the deceptive resemblance to a vitamin may smell or even taste like a vitamin to a fabric-feeding insect, but it will never serve the same purpose. Once taken into the system of the insect, the antimetabolite becomes an inhibitor antagonistic to the vitamin it resembles. The imitation vitamin does not fit into the digestive processes, and physiological complications develop and interrupt normal metabolism.

When low-level antimetabolites are applied to test fabrics, early instar larvae driven by hunger to eat increasing amounts of the pseudo-vitamins soon die of either a vitamin deficiency or some other hastened form of starvation. Yet fiber damage can be determined only by microscopic examination. The more matured larvae, with reserves of accumulated adipose tissue, eat sparingly of the treated fibers and then move off. If matured larvae are confined to the treated fabric, they do not accept the altered diet and eventually die of starvation. In this respect, the fabric has been made immune to insect attack.

Fabric-feeding insects have a specific need for nicotinic acid—niacin—and, to a lesser degree, for pantothenic acid but little need for the remaining components of the B-complex. Although important,

Furniture carpet beetle larvae feeding on test fabric.

Webbing clothes moth adult and larvae damage to fabric.

vitamins alone do not satisfy the nutritional requirements of fabric insects.

Wool is one of the protein fibers. The long-chain molecules—polypeptides—which make up the protein fibers are built up by nature from alpha-amino acids. The four classes of amino acids found in protein fibers comprise a total of approximately 18 acids.

Wool contains chemicals other than amino acids, but not enough of the necessary ones to fulfill the total dietary requirements of fabric insects. Therefore, the proteinaceous bulk of the fibers alone must be essential and, from this protein, certain amino acids apparently are of utmost importance. The differences between amino acid assimilation from the ingestion of wool and the amounts synthesized by the insect must be considered.

A study of the effect of 16 amino acid analogs, hot-water-impregnated into test fabric, was made on the young larvae of clothes moths and carpet beetles, to learn which amino acids are of prime importance and the amount of analog required to neutralize this life-sustaining substance.

Phenylalanine, a nutrient essential to the growth of rats, was found to be of equal importance to fabric insects. Tyrosine, classified as nonessential to growth in rats, was second to phenylalanine in importance to the insects, but more essential to clothes moth larvae than to carpet beetle larvae. Lysine, another amino acid classified as essential to growth in rats, had little effect on carpet beetle larvae but a noticeable effect on clothes moth larvae. L-cysteine—Djenkolic acid—also is required by clothes moth larvae. Other amino acids were of minor importance.

The vitamin-antimetabolites are important ingredients of a colorless, odorless and harmless means of fabric pest control, but the effective amino acid inhibitors are even more important. Both types of ingredients are combined in current experiments on the control of fabric insects.

Antimetabolites can be impregnated permanently into fibers during the water boil of the dye-vat process and—because the majority of the antimetabolites used are insoluble in organic solvents—they are not removed by subsequent dry cleanings. Experiments have shown some antimetabolites can endure six consecutive dry cleanings in pure benzene and carbon tetrachloride and retain their insect-proofing properties.

Work in the field of modern dyeing embracing the practices of vat dyeing, which involves the sodium-leuco forms and reconversions—oxidation—is directed toward the discovery of a process that will level well, possess good wash-fastness, and assure insect proofing permanency.

Antimetabolites, applied at rates not exceeding 2% in aqueous solutions or 3% in alcohols, leave sufficient residue to control fabric insects but contain nothing harmful to humans or pets.

Effective vitamin antimetabolites are quite inexpensive and have long-lasting properties. Aqueous solutions are quickly prepared and easily applied with a suitable sprayer. Because water does not soften the backings of carpeting, an aqueous spray can be used to penetrate any deep-pile carpeting without impairing the backing.

The alcoholic solutions of antimetabolites are designed for use on some fabrics where shrinkage could not be tolerated.

Antimetabolites control existing fabric pest infestations and immunize the fibers against future attacks. In laboratory demonstrations, the richest of nutrients added to antimetabolite-treated fabrics did not yield a suitable food for the insects. Also, antimetabolites applied over existing food and liquid stains high in elements of the vitamin-B complex neutralized the nutritional values in the stains.

Another advantage in the use of these materials lies in the probability that fabric insects may never develop a resistance to antimetabolites.

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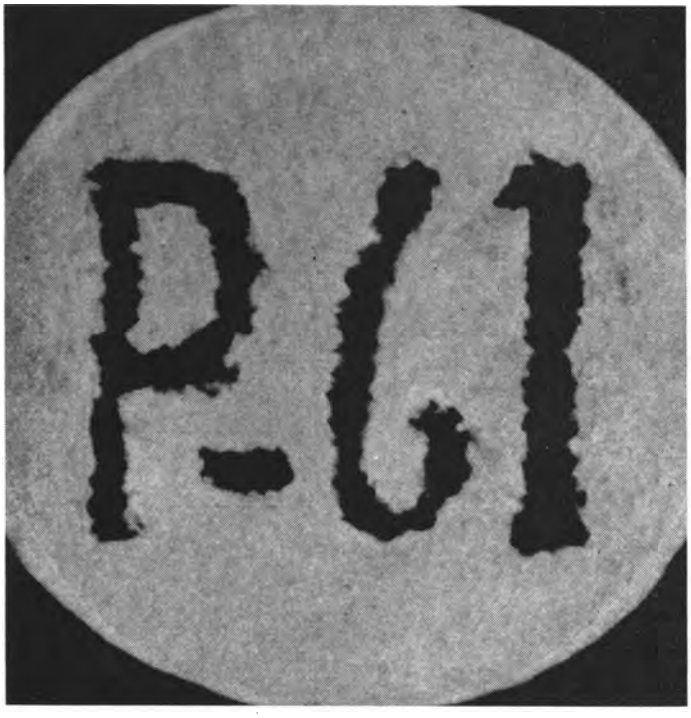
Shelf life of an aqueous mixture of a combination of antimetabolites after four months of standing. In free selectivity larvae devoured the untreated experimental symbol, P-61, and left the surrounding treated portions undamaged.



Results of free larval selection. *A*—Check, first consumed. *B*—Low-level antimetabolite, third consumed. *C*—Full-level antimetabolite combination, not consumed. *D*—Cationic surfactant, second consumed. *E*—Stomach poison, fourth consumed.