Utilization Research on Hides and Leather

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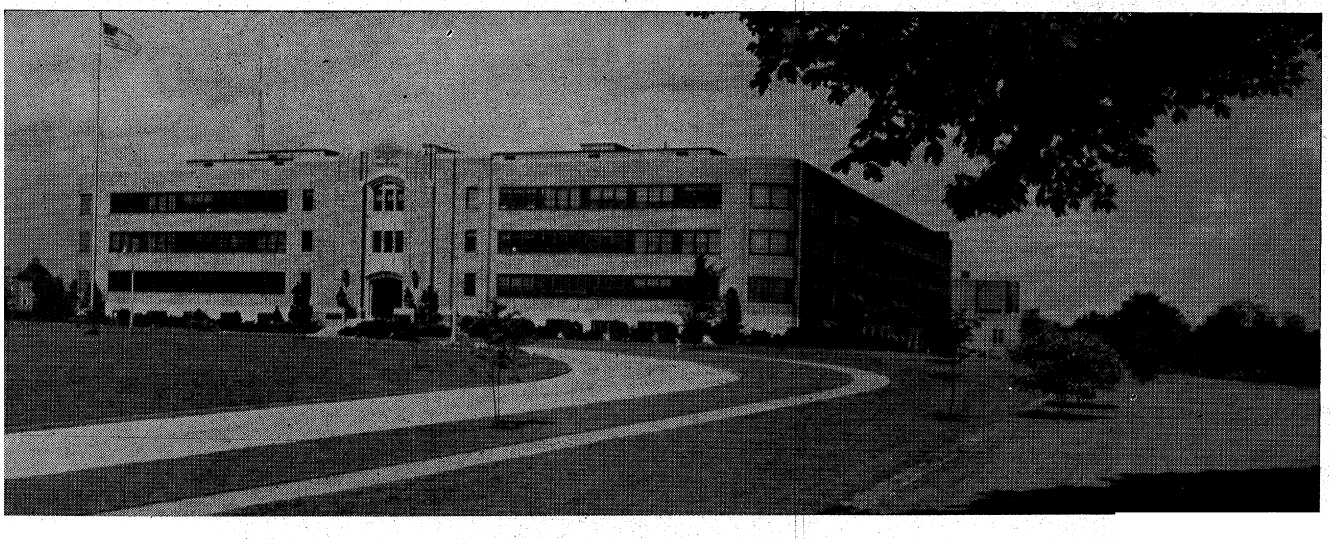


Headquarters of the Eastern Utilization Research and Development Division, in the Philadelphia suburb of Wyndmoor, Pennsylvania. The Hides and Leather Laboratory is one of a number of laboratories housed here where research is done to find new and wider uses for agricultural products.

By The U. S. Department of Agriculture

For well over 50 years, the U. S. Department of Agriculture has been doing research on hides and leather. Back in 1904, when the program started, the primary objective of the work was to conserve our insufficient supply of domestic hides and skins by improved methods of flaying, curing, and handling. Research on leather was mainly directed toward preventing deterioration and increasing serviceability.

Emphasis was still on conservation as late as 1941, when this work was transferred to the new Eastern Regional Research Laboratory, near Philadelphia. The coming of World War II had produced unprecedented demands for leather. Even more serious than the inadequacy of our hide supply was the cutoff of imports of tanning materials. Leather became seventh in the Nation's list of most critical materials, and a feverish search for domestic tannins occupied much of the research effort. One of the results of this work was the development of a technology for extracting tannin from the roots of Canaigre, a wild plant of the Southwest. Another was the development of a process for improving the serviceability of insoles by alum retanning.

The postwar years brought a phenomenal increase in meat production and the hide supply quickly rose. At the same time the demand fell as a result of the increasing use of synthetic substitutes for leather. In 1951-52, the United States became an exporter instead of an importer of hides.

Reflecting the changed situation, the leather research program of the Department of Agriculture was reorganized in 1953. The emphasis was shifted from conservation to utilization. The primary objective became one of developing better, more versatile, and more economical leathers to meet the challenge of the synthetics.

Over the past 6 years, a balanced program of both basic and applied research geared to meet this objective has been underway. It is centered at the Eastern laboratory, now known as the Eastern Utilization Research and Development Division of the Agricultural Research Service, and also includes work done at the laboratories of industrial, educational, and private research organizations where specific problems are being studied under Department of Agriculture contracts.

The program is divided roughly into four categories, two of which are primarily basic research, and two are applied studies on specific developments in leather technology. The basic work includes investigations of the *composition* of hides and skins and their *chemical modification.* The applied studies are concerned with the improvement of *processing techniques* for producing leather, and with the development of *new tannages.* Specific research activities included in this program are depicted by the photographs shown here.

Composition

Hide is a complex substance consisting of proteins, carbohydrates, lipids, and minerals. Before we can understand fully what we are doing to a hide when we cure it, remove its hair, tan it, and perform the other processes necessary to convert it to leather, we must learn how each of these processes affects these components individually and in combination.

Not only *what* the components of a hide are, but *where* they are lo-

Left — Dr. Milton Lapidus, a Fellow of the National Renderers Association, determines the amino nitrogen in a sample on the Van Slyke apparatus, as part of his study of the chemical composition of meat and bone meal.

Center — Dr. Wallace Windus, Head, Processing Investigations (left), discusses with Mr. Hartzell J. Willard the extraction of tannin-bearing plants as part of the program to develop domestic sources for vegetable tannins.

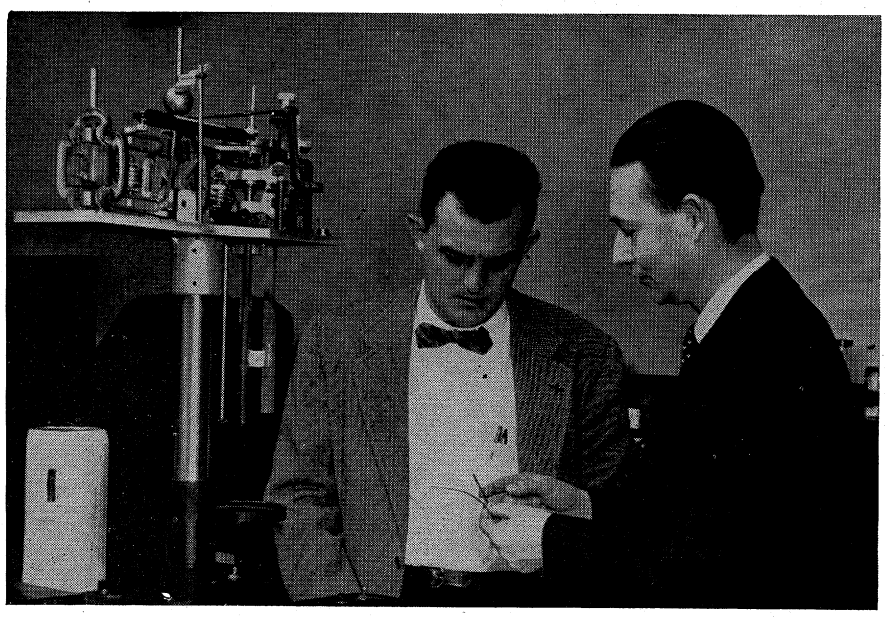
Right — Mr. Clarence W. Beebe measures the thickness of sole leather, one of the many tests used to evaluate the quality of leathers produced by dialdehyde starch pretannage.

cated within the structure, can be of considerable importance to leather quality. Stratigraphic techniques have shown, for example, the distribution of elastin within the three-dimensional structure of cattle hide, and these investigations may prove to be of considerable importance to the flexibility of leather. The role of elastin in determining the surface properties of full-grain leathers is now being investigated for the Department of Agriculture by the University of Cincinnati. The basement membrane of cattle hide is also under further study at the Lowell Technological Institute.

The concept of relating fiber properties to fabric properties, which has yielded much valuable information in the textile field, is now being applied to leather. The Textile Research Institute, Princeton, New Jersey, is now studying, under a Department of Agriculture contract, the physical properties of isolated collagen fibers and the translation of these properties into the fabric properties of leather.

Since leather has a physical resemblance to textiles and is chemically similar to other high polymers, the techniques of high-polymer chemistry are being applied by Department of Agriculture scientists to reveal the basic and fundamental physical-chemical properties of hides and leather. In this area, research is also being conducted on the physical chemistry of soluble collagens.

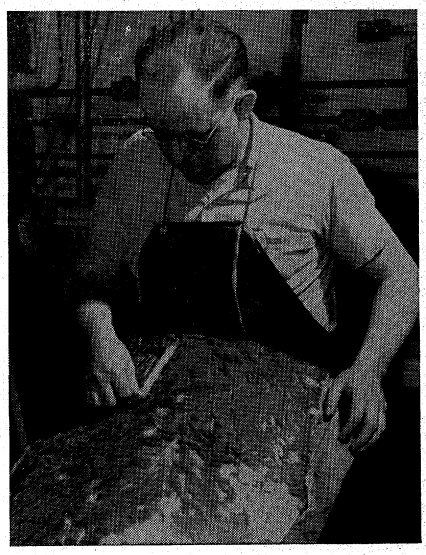
The waste products of tanneries are also under study in this program from the standpoint of basic chemical composition. New uses are being sought for the animal protein residues now being sent to renderers for conversion to animal feeds and fertilizers. Composition studies on meat and bone meal are being supported by a Fellowship from the National Renderers Association.



Dr. Joseph Naghski, Chief, Hides and Leather Laboratory (right), discusses with Dr. Lee P. Witnauer, Principal Physical Chemist, the physical phenomenon of melting as identified with the shrinkage of hide substance. The instrument used for making these precise measurements was designed and constructed at the Eastern Division.

Chemical Modification

Leather is tanned by certain organic and inorganic materials which react with the functional groups of the collagen molecule. In the development of new tanning materials, it is important to know what changes in physical and chemical properties of the collagen are induced by such

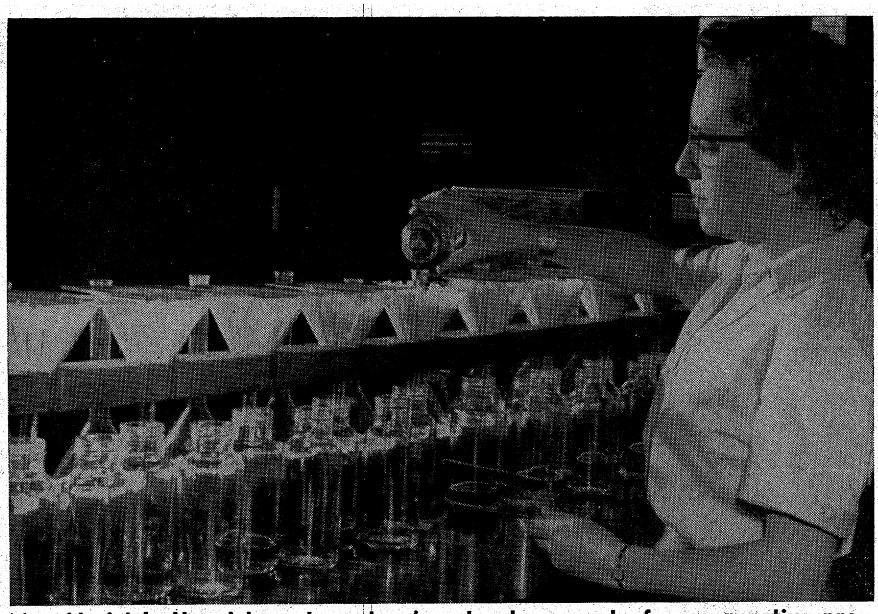


"Thumb test" is applied by Dr. Theone C. Cordon to determine ease of removal of hair from hide treated with enzymes.

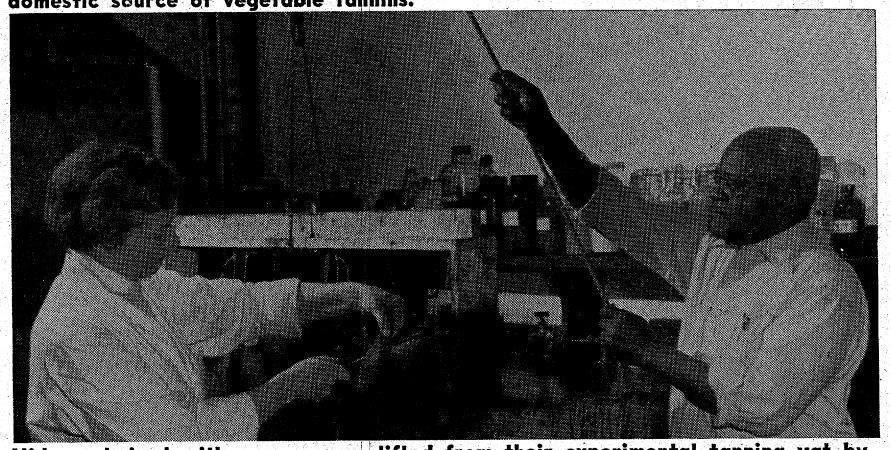
reactions. This research has uncovered two promising aldehyde tannages, dialdehyde starch and glutaraldehyde. Dialdehyde starch is particularly interesting since it can be made from corn, a domestic agricultural crop presently in serious surplus. The glutaraldehyde produces a high-quality garment leather. Another example of the research on chemical modification is the finding that tanning with an epoxy resin imparts reversible shrinkage to leather. Further research may discover a profitable application for this unique property.

Processing Techniques

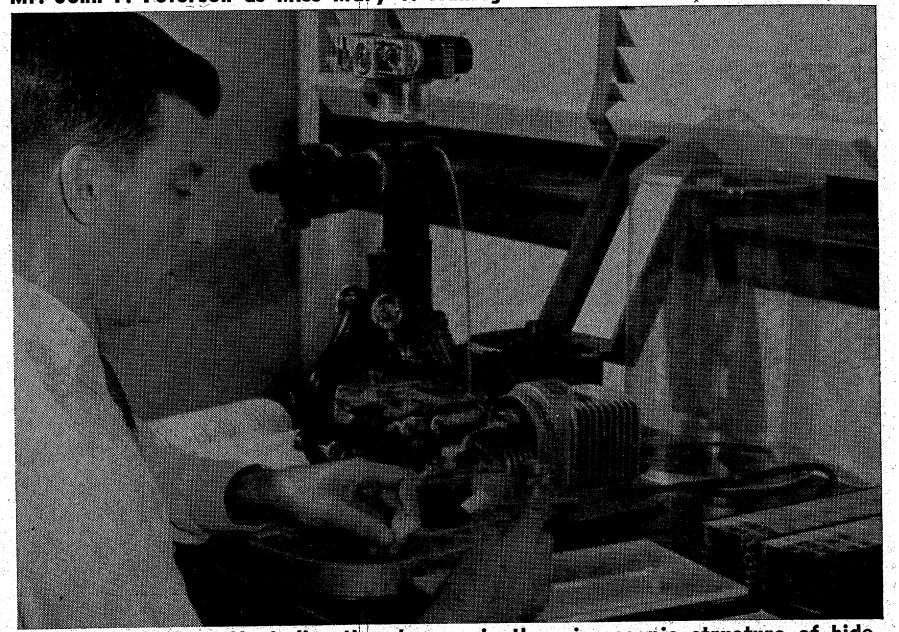
Speed and economy of processing and quality of finished leather are the aims of research on the techniques followed in leather processing. Now under development in this field is a new, quick method of removing the hair from hides by the use of enzymes instead of lime. Perfection of such a process would not only save time, but may enable packers to remove the hair from hides before shipping them to the tannery, thus saving shipping costs and permitting more accurate grading of hides.



Mrs. Muriel L. Happich analyzes tannin extracts as part of a cooperative program with the U. S. Department of Agriculture's Crops Research Division, Beltsville, Maryland, on the development of improved strains of canaigre, a potential domestic source of vegetable tannins.



Hides unhaired with enzymes are lifted from their experimental tanning vat by Mr. John F. Peterson as Miss Mary V. Hannigan cuts off a sample for analysis.



Mr. Alfred L. Everett studies the changes in the microscopic structure of hide and leather produced by tannery operations. Photomicrographs in color and black and white become part of the permanent record.

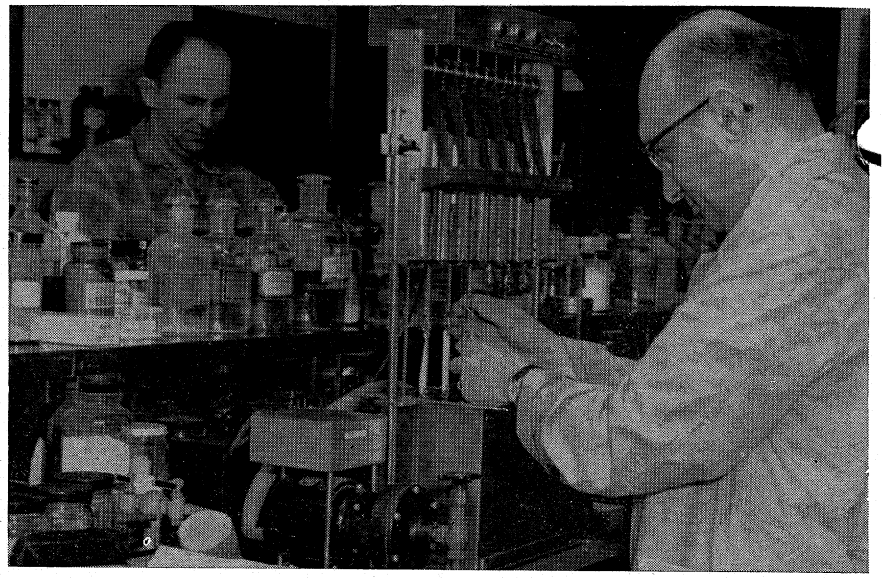
Through the years improvements in tannery methods have reduced the time necessary to make leather. The production of sole leather with vegetable tannins, however, still remains a long process, requiring many weeks for completion. Methods of speeding up this process are now being investigated.

Mr. William F. Happich checks on the progress of a service test made by postmen wearing shoes with canaigre-tanned soles and alum-retanned insoles.

Retanning procedures are also under study as a means of improving the serviceability of leathers. Alum retannage of insoles, for example, has been shown to improve their resistance to wear, water penetration, and deterioration from perspiration and chemicals. Arrangements have recently been completed with The British Leather Manufacturers Research Association for a fundamental study of the mechanism by which chemicals, heat, perspiration, etc., deteriorate leather.

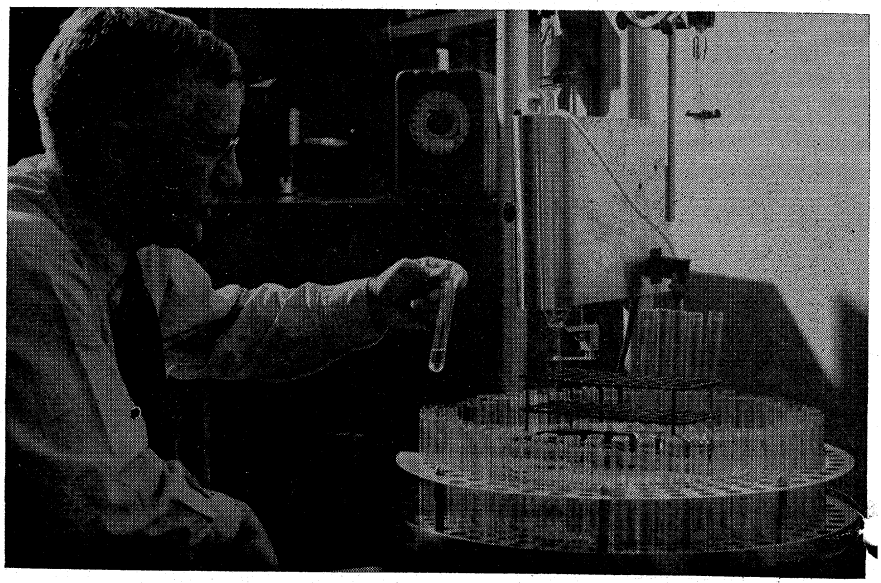
New Tannages

Out of the basic studies on the chemical modification of hides and hide proteins have emerged some completely new tanning agents. Canaigre, discovered through wartime research, has been used experimentally in the tanning of shoe soles by the Quartermaster Corps. Such compounds as dialdehyde starch, glutaraldehyde, and epoxides are now being used for the production of experimental leathers. Use of dialdehyde starch as a pretan, for example, is now being investigated in pilot-scale studies as a means of appreciably shortening the process of vegetable tanning of sole leather. Other experiments indicate that glutaraldehyde is a most efficient tanning agent which promises to produce leather resistant to both perspiration and laundering.



Mr. Alfred H. Korn (left) and Mr. Martin L. Fein conduct analytical studies for the evaluation of the properties of chemically modified hides.

Dr. Edward M. Filachione, Head, Chemical Modification Investigation (left), and Mr. Edward H. Harris, Jr., examine a skin tanned with dialdehyde starch in an experimental drum.



Dr. Edward F. Mellon, Head, Composition Investigations, determines the composition of isolated hide proteins by using ion exchange chromatography to fractionate and identify the amino acid components.