

## **ELECTRON BEAM IRRADIATION OF FRESH HIDES, SALTED HIDES AND LEATHER. MICROBIAL CONTROL AND EFFECT ON PHYSICAL PROPERTIES.\***

### **Abstract**

This study is the first report of the effects of electron beam irradiation on the physical properties and microbial activity on fresh and brine cured cattlehides. The results were similar to those found on treatment of raw skins with gamma irradiation which had previously been reported by several laboratories. Samples of fresh hides, brine cured hides and chrome tanned crust leather were irradiated with an electron beam at levels up to 60 Mrads. At a level of 5 Mrads of irradiation microbial activity on fresh hides was eliminated for 28 days. There was a loss in tensile strength and ball burst compared to the control at this level of irradiation. Irradiation of chrome tanned crust leather containing 55 percent moisture at 20 Mrads caused a severe loss in tensile strength relative to the controls. Leather with a 16 percent moisture content had less damage.

### **Introduction**

An economical and reliable alternative to salt for the preservation of hides and skins has been a research objective of the hide and leather industry for several decades. Many non-salt chemical and physical methods of preservation have been proposed but none have achieved widespread commercial use. Salt curing with saturated salt brine is the method of choice to cure hides. Brine curing is economical, relatively reliable and can be accomplished without sophisticated equipment. Brine curing, however, also has limitations. These include increased effluent pollution for both the tanner and hide processor, the corrosive nature of concentrated salt solutions, the difficulties associated with shipping salted hides, and a reduced area yield and lower grain quality in the finished leather compared with fresh hides. Nevertheless only a significantly cheaper preservation method or regulation of salt pollution is likely to change current practice.

Several papers have described the treatment of hides and skins with gamma radiation for the purpose of preservation. The major technical limitation of this treatment was the physical damage to the structure of the skin caused by the irradiation. Bowes and Moss (1) irradiated collagen powder from limed oxhides, wet and dry, at 5 and 50 Mrad of gamma radiation. Changes in X-ray diffraction pattern, solubility and physical properties

indicated extensive alteration of molecular structure and breakdown of the collagen to lower molecular weight units. Damage was greatest when the material was irradiated while wet. Strakhov *et al.* (2) irradiated salted sheepskins with gamma radiation at levels from 1 to 10 Mrad. At the highest levels, shrink temperature and tear resistance decreased while bonding of the wool to the skin increased. Pietryzkowski *et al.* (3) irradiated raw calfskins with 2.5 to 3 Mrad and reported preservation as effective as salt curing. The radiation killed all of the living bacteria and their spores. He further claimed that the irradiated skins retained their resistance to bacteria. It was not clear how the hides were held after treatment. There is no reason to expect that there would be a residual preservative effect due to irradiation. When Strakhov *et al.* (4) irradiated raw hides using 100 Mrads of gamma radiation hide decay was inhibited for up to 15 days at 18 to 20°C. No mention was made of the physical condition of the hides. When he irradiated wet salted sheepskins with 0.5 Mrad gamma rays from a Cobalt <sup>60</sup> source, he found no adverse effect on the hides stored in a warehouse for 6 to 8 months. Irradiation of hides in the presence of 0.7 percent formaldehyde was also shown by Strakhov and Kolarkova (5) to be effective in holding hides for two months without deterioration. Irradiation of leather containing 8.0 percent moisture caused a measurable change in tensile strength even at a dose of 1.5 Mrads. DuPlessie *et al.* (6) reported that the addition of antiseptic to green hides prior to treatment with gamma irradiation reduced the dose required to achieve one month preservation. This would also be expected to reduce any physical changes to the hide due to irradiation. However, they did not report any post-irradiation physical measurements on the hide.

This study is the first to use high energy electron beam irradiation as a means of controlling the microorganisms found on fresh and salted hides. It also examines the effects of electron beam irradiation on the physical strength of fresh hides, salted hides, and crust leather.

The mechanism of the effect of irradiation on biological material of both gamma radiation and electron beam irradiation is similar (7). Gamma irradiation generates high energy electrons when it is absorbed by individual molecules within the material being irradiated. These high energy electrons are responsible for the observed biological effects. Electron beam irradiation, in contrast, is a direct source of high energy electrons.

According to Thomas *et al.* (8) there is a difference in the biological effect of the same dose from these two forms of irradiation due to the difference in dose rate of application. The dose rate of electrons from an electron beam is much higher than that from gamma irradiation. As a result electron beam irradiation generates more heat during treatment which could have an adverse effect on heat sensitive materials. The complete destruction of the microbial population on a hide would require a longer irradiation period when using comparable doses of gamma irradiation because of the lower rate. This would at least theoretically permit more degradation of the grain layer of the hide by microorganisms present on the green hide. The difference in grain quality would probably not be measurable unless over 12 hours were needed for gamma irradiation. Electron beam irradiation has other advantages over gamma irradiation. The electron beam is produced in a linear accelerator which can be turned off when not in use. Gamma irradiation requires the installation of a constantly emitting radioactive source. Once installed the gamma source undergoes a constant decay in intensity which must periodically be upgraded by addition of new source material while the level of electron beam irradiation is constant. The greater penetrating power of gamma radiation requires a higher initial capital investment to construct a safe irradiation facility. Radioactive sources are of necessity more rigidly regulated than electron beam sources. Use of electron beam irradiation to control microor-

ganisms in other areas is well established. Large quantities of prepackaged medical supplies manufactured in the United States are routinely sterilized by electron beam radiation.

The primary objective of these experiments was to determine whether the levels of irradiation needed to control the microbial populations on fresh and salted hides caused unacceptable physical damage to the hides which would interfere with subsequent manufacture of leather products. A secondary objective of the research was to determine whether chrome tanned crust leather trimmings could be economically physically degraded for chrome and protein recovery.

## **Materials and Methods**

### **SAMPLE PREPARATION**

Fresh cattle hides were obtained within 3 hr of slaughter from a local meat packer. The hides were chilled with crushed ice and held in plastic containers until sampled. Brine cured hides were obtained from a commercial hide dealer. A series of two in diameter samples were cut from both fresh and brine cured hides using a circular punch. This provided a uniform sample for ball burst measurements and an estimate of microbial activity on the sample. Samples were removed systematically from the hide from head to tail in rows parallel to the backbone. As samples were cut from the hide, they were alternately designated either for treatment or as controls. Physical test measurements of irradiated samples were always compared to adjacent control samples to minimize the influence of the natural variation in strength found in different areas of the hide. Each sample was heat sealed in a labeled plastic freezer bag. Samples from the fresh hide were held on ice until they were irradiated approximately 24 hr after slaughter. A second series of samples were cut from the fresh hides for tensile strength measurements using a dumbbell shaped tensile strength die approximately 6 in long and 1 in wide. These samples were not tested for microbial activity.

A third series of tensile patterns were cut from four sides of commercially prepared chrome tanned crust leather from the same pack. Half of the samples cut from the crust leather patterns were soaked in tap water for 15 min., drained, and held overnight in a closed container to allow the moisture to equilibrate within the sample. These samples were not examined for microbial activity.

### **ELECTRON BEAM IRRADIATION**

Electron beam irradiation was generated by a 3 MEV Van de Graaff linear accelerator. The unit was provided by High Voltage Engineering of Burlington, Mass. 01803\*. Radiation dosage is a cumulative process and total irradiation is a function of the length and strength of exposure. In this facility each sample was exposed to 0.5 Mrads of irradiation at ambient temperature as it passed under the electron beam at a constant linear rate of 1 ft/min. Doses larger than 0.5 Mrad were achieved by the appropriate number of passes of the sample under the beam.

## MICROBIAL DETERMINATIONS

Hide pieces (2 in diameter circles) were stored at room temperature in sealed bags after irradiation. At predetermined intervals hide samples were removed and agitated for 10 min in 500 ml of 0.1 percent peptone (Difco) for the fresh hide pieces and 500 ml of sterile saturated brine for the brine cured pieces. Dilutions of washes from fresh hide pieces prepared in sterile 0.1 percent sterile peptone water and appropriate dilutions were plated onto Plate Count agar (Difco). Dilutions of the wash samples from brined hide pieces were prepared in sterile brine and appropriate dilutions were plated onto both Plate Count agar and Obligate Halophile agar (10). Dilutions of brined hide washes at 28 days after irradiation were plated onto Obligate Halophile agar containing only 2/3 of the NaCl level. Plates were counted after 3 days incubation at room temperature. The lowest detectible level of microorganisms was  $5 \times 10^4$  per 2 inch hide circle.

## PHYSICAL TESTS

Two physical strength measurements were done on a Model TTD Instron testing machine. Ball burst, which measures the force required for penetration of a metal rod through the sample, and tensile strength which measures the force required to pull the sample apart lengthwise. These procedures are described in ASTM standard methods (11,12). Ball burst was measured on the circular samples after they were washed to determine microbial count. Tensile strength measurements were made only on the samples cut with the dumbbell shaped die.

## Results

The results are divided into two areas. The first deals only with the physical effects of electron beam irradiation on chrome tanned crust leather. The second area is the effect of the irradiation on fresh and brine cured hides and includes the results of microbial determinations and physical tests.

### IRRADIATION OF LOW MOISTURE LEVEL LEATHER SAMPLES

Crust leather at a normal moisture level of about 16 percent was irradiated over a dose range of from 0 to 50 Mrad. Figure 1 shows the relationship between the resulting tensile strength of the leather samples and the dose level of the electron beam irradiation. At low levels of irradiation the variation in tensile strength was similar for both the treated and control samples. As the irradiation dose increased the leather became progressively weaker. At 50 Mrad of irradiation the tensile strength was reduced to about half that of the control.

### IRRADIATION OF HIGH MOISTURE LEVEL LEATHER SAMPLES

The samples of the crust leather soaked in water and containing a moisture content of 55 percent were irradiated over the same range as the dry pieces. The loss in physical strength (Figure 2) of high moisture content samples was consistently greater at equivalent levels of irradiation than the low moisture samples. At 50 Mrad the strength was only 10 percent of the control. At levels of 30 to 40 Mrad the leather could be easily torn. This result can be explained by a general breakdown of collagen molecules in the hide by irradiation. This is supported by the observation by Bailey and Rhoads (9) that there was a fourfold increase in extractable hydroxproline in beef muscle irradiated at four Mrad. This was accompanied by an increase in tenderness which they attributed to breakdown

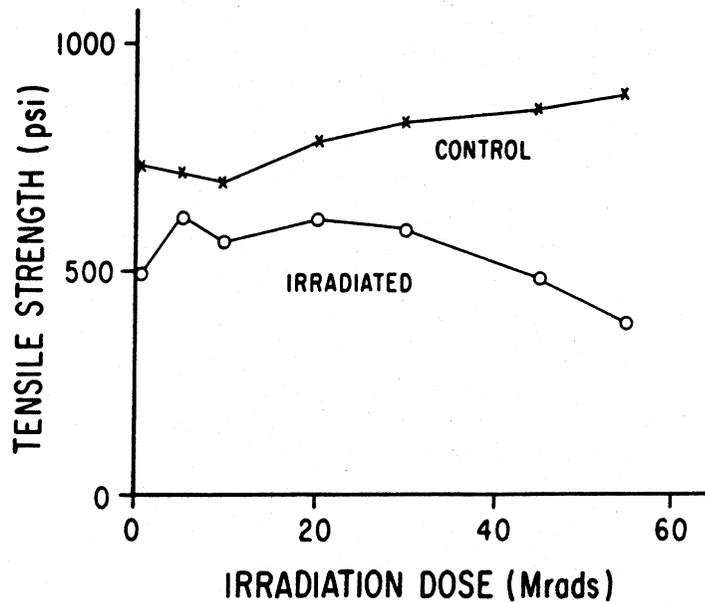


Figure 1.—Effect of varying levels of 3 MEV electron beam irradiation on tensile strength of crust leather containing a low level of moisture (12 percent)

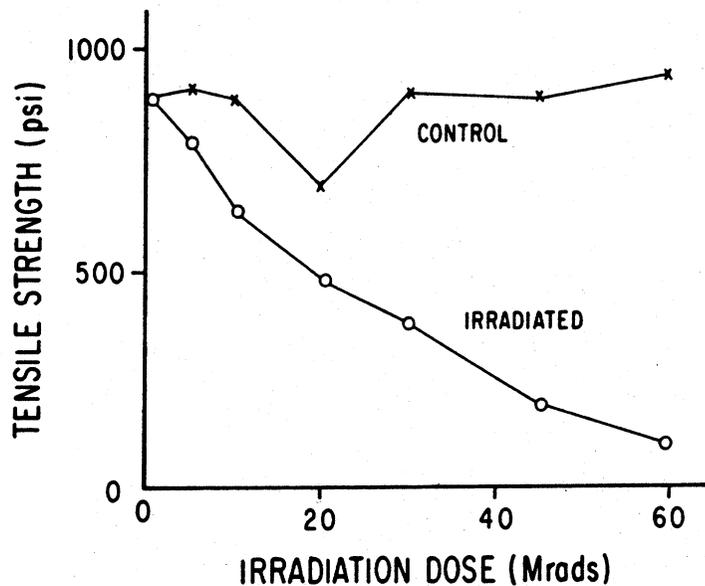


Figure 2.—Effect of varying levels of 3 MEV electron beam irradiation on tensile strength of crust leather containing a high level of moisture (42 percent).

of the collagen in the meat. Similarly the loss in strength we observe in the irradiated hide is probably due to collagen breakdown.

The level of irradiation required to reduce the tensile strength to values below 100 psi is probably not of practical use. Leather scraps have an intrinsically low value and the cost of energy required to significantly weaken the fibers would not be recovered from the separated protein and chromium products.

**TABLE I**

MICROBIAL COUNTS ON FRESH HIDE SAMPLES AT INTERVALS AFTER ELECTRON BEAM IRRADIATION

DAYS <sup>1</sup>	IRRADIATION DOSE* (Mrads)						
	0.5	1	1.5	2	3	5**	40
7	10 <sup>10</sup>	N.D.	10 <sup>6</sup>	10 <sup>7</sup>	0 <sup>+</sup>	0	0
10	10 <sup>10</sup>	10 <sup>9</sup>	10 <sup>10</sup>	10 <sup>9</sup>	0	0	0
14	10 <sup>10</sup>	10 <sup>9</sup>	10 <sup>10</sup>	10 <sup>9</sup>	0	0	0
18	N.D.	N.D.	N.D.	10 <sup>9</sup>	0	0	0
21	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>6</sup>	0	0
28	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>6</sup>	0	0

\*Unirradiated controls not run. <sup>1</sup>Days after irradiation. \*\*Doses of 10, 15, 20 and 30 Mrads also had 0 counts. +Lowest count detectible is 5 x 10<sup>4</sup>/sample. N.D.-Samples not counted.

**MICROBIAL COUNTS ON IRRADIATED FRESH HIDES**

Unirradiated fresh hides initially contained an average of 1 X 10<sup>8</sup> organisms per two inch disc. Microbial densities on non-irradiated samples were measured only up to 3 days of storage at room temperature. After this time they were at a stage of putrefaction which precluded handling. As shown in Table I, a radiation dose of 3 Mrads was sufficient to control microbial growth under the test conditions for up to 18 days. All doses equal to or greater than 5 Mrad retarded microbial growth for the full 28 days duration of this experiment. There were two exceptions out of 70 samples and this probably indicates that the bags containing these samples were not properly sealed, allowing recontamination after irradiation. This radiation threshold found for the control of microorganisms on fresh hides is similar to that reported by Pietrzykowski *et al.* using gamma irradiation (3).

**MICROBIAL COUNTS ON IRRADIATED BRINE CURED HIDES**

Irradiated and control brine cured hides were washed with sterile saturated brine for detection of halophiles. Dilutions of the wash were made with the same solution and samples were plated on both plate count agar and halophilic agar for microbial counts. No microorganisms were detected on either medium up to 28 days post-irradiation. On the basis of appearance and odor, however, it was apparent that some of the hide samples contained a significant microbial population.

It was postulated that the organisms present in these samples required salt for growth, but could not survive at the salt level found in the conventional halophilic media used (approximately 3.5 M). To test this hypothesis, brine washes from the irradiated brined hides, 28 days after irradiation, were applied to a modified halophilic media identical to that previously used except for the sodium chloride concentration which was reduced by one third to 2.34 M. Under these conditions unirradiated brine cured samples were found to contain more than 10<sup>8</sup> organisms per gram. A radiation dose of one Mrad reduced the count to 1 X 10<sup>6</sup>. Radiation dosages equal to or greater than two Mrads completely eliminated these microorganisms from the brined hide. It was speculated that the organisms growing on these hide pieces are not true halophiles but should be termed intermediate halophiles.

**PHYSICAL PROPERTIES OF IRRADIATED FRESH HIDES**

Measurement of ball burst on the irradiated and control samples of the fresh hides resulted in the data in Figure 3. Measurements were not made on samples which were

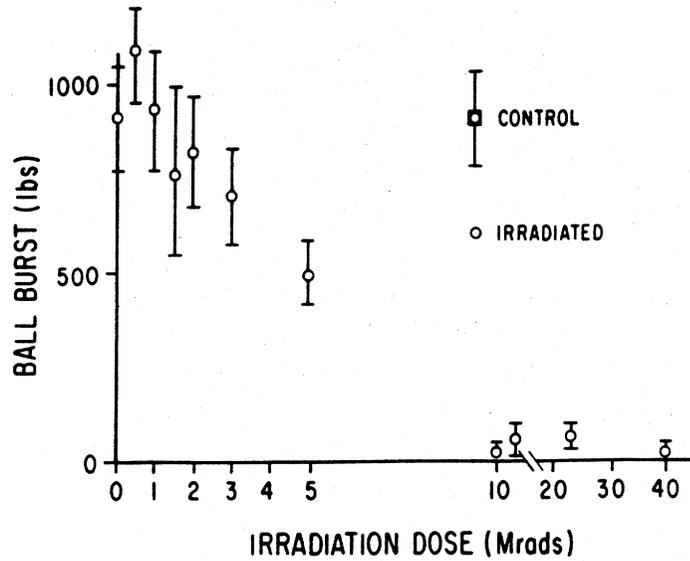


Figure 3.—Effect of varying levels of 3 MEV electron beam irradiation on ball burst measurements on samples from fresh cattlehide. Values averaged from samples held from three to 28 days after irradiation.

heavily contaminated with microorganisms. A decline in physical strength over the controls as measured by ball burst values was observed as the level of irradiation was increased. The value used for the control as obtained from several samples which were tested two days after the experiment was started. Control samples could not be held any longer without severe bacterial contamination. The ball burst measurements of samples irradiated at 5 Mrad were about half the control. At 10 Mrad the samples lost more than 90 percent of their original strength. Individual ball burst measurements did vary from sample to sample.

Measurement of the tensile strength of the fresh hides also indicated a decline in strength as irradiation increased. The variation seen in the control samples is due to the location of the samples in the hide. Test samples are all compared to control samples which were

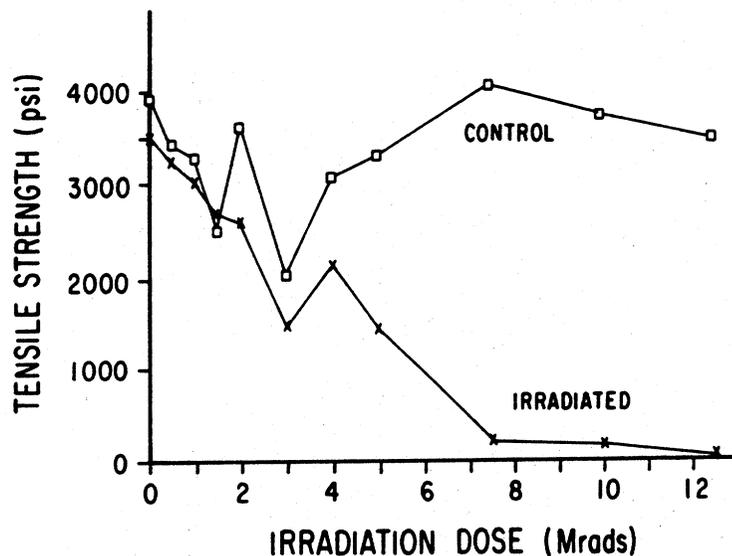


Figure 4.—Effect of varying levels of 3 MEV electron beam irradiation on tensile strength measurements made on samples from fresh cattlehide. Values averaged from samples held from three to 28 days after irradiation. Control values all run within two days after experiment started.

cut out from adjacent areas on the hide. All of the controls were tested for tensile strength within two days after irradiation of the test samples. In Figure 4 it can be seen that at 7 Mrad of irradiation the loss in tensile strength was greater than 90 percent.

As the doses of irradiation increased from 10 Mrad and greater, samples become warmer to the touch. Simultaneously they become more turgid and at levels of 20 Mrad and beyond, they became very stiff. It is not likely that these samples could be converted into satisfactory leather.

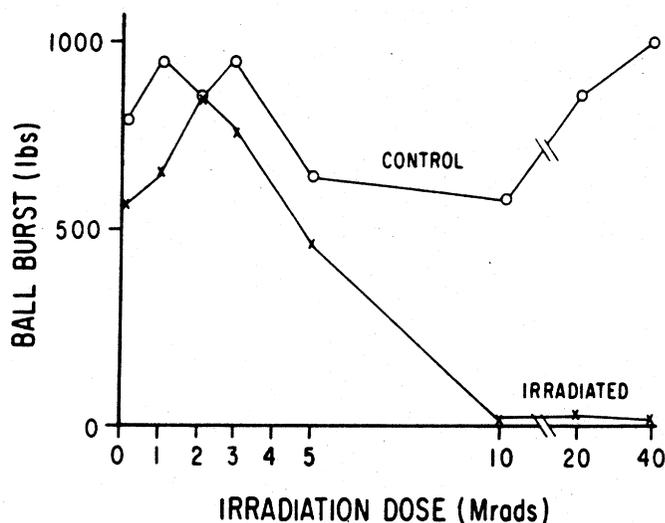


Figure 5.—Effect of varying levels of 3 MEV electron beam irradiation on ball burst measurements made on samples from brine cured cattlehides. Values averaged from samples held from three to 28 days after irradiation.

#### PHYSICAL PROPERTIES OF IRRADIATED BRINE CURED HIDES

The physical test for ball burst was performed on irradiated brine cured hide samples showed similar losses in strength. Figure 5 contains the results of the ball burst measurements at each level of irradiation. The differences in ball burst values were not greatly different from the controls at up to 5 Mrads, however, at 10 Mrads the loss became severe.

### Discussion

Complete elimination of bacterial growth in these experiments required a dose of three Mrads which is higher than needed for sterilization of most materials. This can be explained by several properties unique to the hide. First the hair on the surface of the hide contains numerous disulfide bonds. It is well known that disulfides have a radioprotective effect on microorganisms. The three MEV energy level of the electron beam used in these experiments may not have penetrated the entire sample without significant loss in energy by the time it exited the hide. The water content of any material being irradiated with an electron beam can limit the distance electrons can penetrate. The hide itself is an excellent substrate for microbial growth. If a single organism survived the irradiation, the sample would easily be overrun with microbial growth in a week.

The practicality of the electron beam irradiation for the preservation of fresh hides lies in how sharp the demarcation is between physical change in the hide and complete microbial control. At all levels of irradiation there appears to be some physical effect on the hide. It is not clear if the decreases in physical strength observed at the level where microbial

control occurs will significantly change the final leather product. Leather is intrinsically stronger than most of its uses require and a small decrease in tensile strength might be an acceptable tradeoff for an improved preservation method. Conversion of electron beam irradiated hide samples to leather will be necessary to help resolve this issue.

The cost of applying the electron beam irradiation for this purpose is also unknown and thus the practicability of industrial scale application of this technique remains speculative. Whole hide preservation would require an 8 to 10 ft wide electron beam. The cost of such equipment is likely to be prohibitive unless large numbers of hides were to be treated. Other factors which must be considered include the higher costs for shipping irradiated hides. Irradiated hides are not dehydrated and would weigh more than brine cured hides. In addition containerization would be necessary to prevent re-contamination. On the other hand irradiated hides are quite similar to fresh hides in appearance. If they respond to processing in same way they would have an increased area yield compared to brine cured hides.

The intermediate halophiles which we detected have not previously been identified as part of the microbial flora of hides. These organisms do not grow in the presence of 3.5 M salt nor do they grow in the absence of NaCl. They were found to grow in media containing salt at two thirds the normal level of salt (2.3 M) in halophilic media. Such organisms would not be expected to pose a threat to hide quality in well brined hides. However if curing were not done properly resulting in intermediate salt concentrations within the hide these organisms would be expected to flourish. Under these conditions they could have a significant negative effect on hide quality over long storage periods. These organisms were eliminated from the irradiated brine cured hides at 2 Mrad, a lower dose level than needed to eliminate microbial growth on fresh hides. Kallenberger (13) suggests that long term storage of brine cured hides at warm temperatures can lead to microbial degradation of the grain surface by halophilic organisms. This has been cited as a serious problem for shipments of hides to the Far East. We didn't observe the halophiles Kallenberger reported possibly because the plates were not incubated long enough to observe viable colonies. The electron beam irradiation did control the organisms which grew on the partially saturated salt plates.

At dose levels of the electron beam irradiation above 20 Mrad the hide samples became warm to the touch. Levels of 30 Mrad and above caused the samples to become swollen and stiff. It appeared that at these higher doses the shrink temperature of the hide was exceeded. In some cases gelatinization took place on the surface of the sample.

## Conclusions

- (1) Electron beam irradiation of both dry and high moisture content leather caused a measurable decrease in physical strength at levels greater than 5 Mrad. The effect was more pronounced at higher moisture contents. This effect of moisture could be significant in the application of electron beam irradiation for the preservation of cattlehides. Use of electron beam irradiation to physically break down leather scraps to recover chrome and/or protein is probably not a viable alternative to mechanical shredding. The low intrinsic value of the final products would not be sufficient to recover the capital investment necessary for the electron beam irradiation equipment.
- (2) Electron beam irradiation of fresh cattlehides completely controlled the microbial population normally found on the fresh and brine cured hides. This control was accom-

panied by a reduction of physical strength of about 12 percent ball burst and 13 percent tensile strength. It remains to be determined if the leather produced from tanned samples of irradiated hides is affected the same way. The economics of using electron beam irradiation to preserve hides is also unknown. The initial capital investment required for the electron beam equipment may be on the order of two million dollars. If all other conditions for preservation are met in terms of leather quality its economical use would require the processing of large numbers of hides.

(3) The intermediate halophilic microorganisms found on the brine cured hides in this study could also be completely controlled by electron beam irradiation. These organisms were not true halophiles but did require salt for growth. At 2 Mrad of irradiation complete microbial control was obtained. This dose is lower than that needed for microbial control on fresh hides. It was not determined whether irradiation of brine cured hides would significantly increase their shelf life but it is clear that under conditions of poor cure and without irradiation these intermediate halophiles would flourish.

### Acknowledgements

The cooperation of Mr. Sam Maloof, Consultant to High Voltage Engineering and to The Electronized Chemicals Division of High Voltage Engineering, of Burlington, Mass. 01803, who permitted us to use their equipment for these tests and the able assistance of Mrs. Deborah Fleming is acknowledged.

### References

1. Bowes, J.H., and Moss, J.A. *Radiation Research* **16**, 211-223 (1962)
2. Strakov, I.P., Aronina, Y.N., and Bayandina, L.A. *Kozh.-Obuvn. Prom-st.* **17**, 37-9 (1975)
3. Pietrzykowski, W., Pietrucha, K., and Mikula, M. *Pr. Inst. Przem. Skorzanego* **13**, 13-20 (1969)
4. Stakov, I.P., Shifrin, I.G., Levenko, P.I., Pavlov, Y.F., Rybakova, G.D., Kudryashova, A.A., and Medvedskaya, I.T., *Radiats. Obravb. Pishch. Prod. Dokl. Vses. Nauch.-Tekh. Konf.* Edited by Rogachev, V.I. Moscow, USSR 241-6 (1968)
5. Strakhov, I.P., and Kolarkova, A.S. *Kozh.-Obuvn Prom-st.* **20**, 41-4 (1968)
6. DuPlessis, T.A., Russell, A.E., Stevens, R.C.B., and Galloway, A.C. *Radiat. Phys. Chem* **22**, 491-502 (1983)
7. Bardley, R. *Radiation Technology Handbook* Marcel Dekker, Inc., New York
8. Thomas, M.H., Atwood, B.M., Wierbicki, E., and Taub, I.A., *J. Food Sci.* **46**, 824 (1981)
9. Bailey, A.J., and Rhodes, D.N. *J. Sci. Fd. Agric.*, **15**, 504-508 (1964)
10. *The Prokaryotes* Edited by Starr, M.P., Stolp, H., Truper, H.G., Balows, A., Schlegel, H.G. Springer-Verlag, New York Medium 3 for Enumerating Halophiles. **1**, 988 (1981)
11. ASTM Standard D 2207-64 *Bursting Strength of Leather by the Ball Method* (approved 1976)
12. ASTM Standard D 2207-64 *Tensile Strength of Leather* (approved 1976)
13. Kallenberger, W.E., *JALCA*, **79**, 104-114 (1984)

## Discussion

CHRIS EHRET (Chestnut Operating Company, Discussion Leader)

Thank you Dr. Bailey. Are there any questions?

BETTY HAINES (BLMRA): In South Africa, LIRI has used Cobalt 60 radiation and they found that if they treat the hides first with a preservative they can use less than 2.5 Mega rads and the hides were not damaged and were preserved for six weeks. In 1963 we used 2.5 Mega rads and we held them for six months, but they all had to be bagged and sealed. The other problem is that mold may grow through the polythene, which then renders the conditions non-sterile. The thing that interests me as far as making this process commercial is that it will be necessary to transport hides long distances to a radiation unit. Therefore, the hides will have to be preserved in some way with a short term preservative. If by any chance the preservative is ineffective or if there is already some putrefaction inside the hide before the biocide is applied then the hide is transported, will the level of radiation received have to be increased to attack bacteria that are not surface but are within the hide?

DR. BAILEY: No. The electron beam irradiation thoroughly penetrates the hide. One of the differences here is that cobalt 60 radiation sources are very highly regulated and to even build a unit that would even operate requires quite a bit of regulation by the Atomic Energy Commission. The distinct advantage of the electron beam is that that is not a problem.

JEAN TANCOUS (Tanners Council Laboratory): What do you feel about the enzymes that are in the cells of the hide? Do you inactivate the autolytic action?

DR. BAILEY: We have not measured it and I do not know. At some level you definitely would. However, at higher levels the heat generated in the samples starts to turn the collagen to gelatin.

JEAN TANCOUS: You could have hair slip and other changes if you do not stop the enzyme action natural to the hide itself.

DR. BAILEY: I would say that in this case we did not have that problem. The samples that were preserved did not have hair slip.

JEAN TANCOUS: For how long?

DR. BAILEY: For up to 28 days

I. V. PRASAD (A. F. Gallun and Sons): Did you irradiate one skin at a time or did you irradiate a stack of skins?

DR. BAILEY: We used only one piece at a time but due to the power of the radiation source we could have stacked them and done more than one at a time. I think the key to this is going to wind up in what kind of volume can you put through. High Voltage Engineering really did not want to put a price on a machine but when I pressed them they said maybe \$500,000 for a unit. If you are putting a lot of hides through that is not bad. The unit itself is 150 Kw unit so it is really not terribly expensive as far as the cost of applying the radiation. So, the key is how many hides can be put through the unit and how quickly can it be paid off as opposed to brine curing. I think there is some potential there.

## **LIFE LINES**

**MICHAEL J. HAAS** is a Research Biochemist/Molecular Biologist at the USDA's Eastern Regional Research Center in Philadelphia. He received his B.S. degree in Microbiology from the University of Minnesota and his Ph.D. degree in biochemistry from the University of Wisconsin. Dr. Haas also did post-doctoral studies on renal biochemistry in the Department of Medicine at Wisconsin. Between hunting seasons, he is a Lead Scientist in the Biochemistry and Chemistry of Lipids Research Unit. His current research interest focus on the isolation, characterization, modification and expression of genes which encode enzymes useful in the processing of agricultural products containing oleochemicals.