

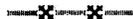
PRESERVATION OF HIDES WITH SULFITE.
I. CONCENTRATION AND APPLICATION
EFFECTS ON SMALL-SCALE EXPERIMENTS
WITH CATTLEHIDES*

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ABSTRACT

This study examines the effects on the length of hide preservation of (a) sulfite concentration, (b) sodium bisulfate and acetic acid as acidulants, (c) sodium bisulfite alone, and (d) various methods of handling and storing the treated hide samples. Small-scale studies indicated that short-term (six days) preservation could be accomplished at concentrations of 0.25 percent sodium sulfite and that 0.5 percent sulfite in combination with one percent acetic acid resulted in long-term (30 days) preservation. The need to containerize the treated side was demonstrated. Sides that were preserved with sulfite, drained, and stored in closed containers for six days at ambient temperatures were made into acceptable leather. An estimated cost of materials for the sulfite preservation compared favorably with the material costs for brine curing.



INTRODUCTION

There is a need in the hide processing industry to reduce substantially or eliminate the level of dissolved solids in tannery and packing-house effluents (1). Today's emphasis on pollution abatement and increasing costs of sewerage treatment provide adequate reason to find methods to alleviate this problem now. S. G. Shuttleworth (2), in his 1973 John Arthur Wilson memorial lecture, stated that it is inevitable that our authorities will one day set an upper limit on total dissolved solids. This has already been done in South Africa. The only way he envisions meeting this standard is by eliminating the use of salt in hide preservation.

Any material or process that replaces salt must conform to certain necessary requirements. It must be reliable and rapidly bring the fresh hide to a stable condition so that deterioration of hide substance does not occur for several months,

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and this must be done without adverse effect on subsequent leather quality. Preferably, it would not require major changes in beamhouse procedures and would be low in cost, nonpolluting, and readily available. An acceptable alternative must provide for both adequate preservation and an acceptable limit of dissolved solids content in the effluent.

In a previous paper by Hopkins *et al.* (3) several short-term preservation methods were described. This work provides additional information on the method using sulfite. Evidence is accumulating in this laboratory that this method has the potential to become a useful alternative to salt preservation.

Most of the experimental work presented is on a series of small-scale experiments to determine (a) the effects of sulfite concentration on the length of hide preservation, (b) the effects of sodium bisulfate and acetic acids as acidulants for the preservations, (c) the effect of sodium bisulfite alone as a preservative, and (d) the effects of various methods of handling and storing the hide samples. Finally, a matched side study was performed to evaluate the leather prepared from sides that were drained of excess sulfite treating solution and then stored for six days in closed containers.

MATERIALS AND METHODS

Samples used in the small scale experiments were 100 g. hide pieces cut from freshly flayed black steerhides which were demanured and fleshed. These samples were probably black Angus steerhides but they were not positively identified when the hides were picked up at the slaughterhouse. Each sample was wrapped individually in aluminum foil and frozen until used. Preservation treatment solutions were applied to the samples after they were completely thawed. All treatment solutions contained 0.03 percent Tergitol† 15-S-9 and the float in all experiments reported was 20 percent unless otherwise indicated. The percent concentration of treatment chemicals was based on hide weight. In all cases, samples were stored at ambient temperatures. Preservation times were referred to as short-term (less than seven days), extended short-term (seven to 30 days), and long-term preservation (greater than 30 days) as defined in our previous publication (3).

The initial experiments examined the effects of sulfite concentrations on the length of hide preservation. Three preservation systems were tested: sodium bisulfite alone; sodium sulfite plus two percent sodium bisulfate; and sodium sulfite plus one percent acetic acid. The concentrations ranged from 0.25 percent to 2.0 percent of the sulfite salt based on the weight of the hide sample‡.

Individual hide samples were put in one-quart mason jars containing the treatment solution and the jars were sealed and agitated on a rotary shaker at approxi-

†Reference to brand or firm name does not constitute endorsement by the U. S. Department of Agriculture over others of a similar nature not mentioned.

‡Care must be exercised in the handling and preparation of acidified sodium sulfite solutions to prevent the evolution of sulfur dioxide gas which could be hazardous.

mately 200 r.p.m. for 15 minutes. The jars were held at ambient temperatures. After one hour, three, six, and 30 or 33 days, hide samples at each concentration level were checked for microbial counts. When a sample developed an off odor, it was the signal that the preservation was failing. The time was then noted and a microbial count was done. The odor of the sample was noted as good, off, or putrified. The putrified samples were, in most cases, discarded without making a microbial count.

In the next series of experiments two preservation systems were used, 1.5 percent sodium sulfite plus one percent acetic acid, and 1.5 percent sodium sulfite plus two percent sodium bisulfate. The samples in these experiments were treated in a plexiglas drum 50 cm. in diameter and 25 cm. in width. The number of samples required for a particular experiment were added to the treatment solution in the drum and were drummed at 10 r.p.m. for 0.5 hour. The samples were then removed and handled as indicated in the individual experiments. It was arbitrarily decided for this group of experiments that if a bacterial count was greater than 20,000 bacteria per gram of hide the preservation was failing.

The matched side experiment was run with fresh demanured and fleshed steer hides which were obtained from a local packing house. They were cut down the backbone and one half placed immediately into the packer's brine raceway. These sides were bundled by the packer and picked up later for further processing. The matching sides were brought to the laboratory and treated with the preservative solution. The sides were placed in a 55 gal. stainless steel drum with treatment solution and the drum was rotated for 30 minutes at 15 r.p.m. The sides were horsed, allowed to drain for 15 minutes, and then placed in covered fiberglass containers.

Microbial counts were used as one indication of preservation. The procedures used have been described by Hopkins *et al.* (3). The method followed for sampling the sides for bacterial counts was to cut three samples of approximately 50 to 100 g. each from the edges of each side. One sample was taken from the exposed top surface, one from the interior of the folds, and a third from a part of the side that was submerged in the treatment solution. The pieces were transferred to a tared sterile mason jar, and weighed.

Hair saving lime treatments were carried out on the hide samples immediately after they were washed for bacterial counts. Hide pieces were submerged for three days in a 400 percent float containing ten percent lime, 0.25 percent sodium sulfhydrate, and 0.25 percent sodium sulfide. The hair could then be easily scraped off and the grain examined.

EXPERIMENTAL RESULTS AND DISCUSSION

Initial Experiments

Sodium bisulfite is a common food preservative. Its effectiveness in preserving hide samples is shown in data presented for Experiment 1 in Table I. The quarter

TABLE I
THE EFFECTS OF SULFITE CONCENTRATION AND VARIOUS SULFITE TREATMENTS
ON HIDE PRESERVATION AS JUDGED BY BACTERIAL COUNT AND SAMPLE ODOR*

Conc. (%) ‡	Period of Preservation								
	0 Dayst		3 Days		6 Days		(X) Days		
NaHSO ₃	Bact./gm. Hide	Odor*	Bact./gm. Hide	Odor	Bact./gm. Hide	Odor	Bact./gm. Hide	Odor	
<i>Experiment 1. Preservation system — NaHSO₃</i>									
0.25	680 x 10 ³	+	876 x 10 ⁸	±	putrified	—	—	—	
0.50	990 x 10 ³	+	45 x 10 ⁶	+	40 x 10 ⁶	—	—	—	
1.0	12 x 10 ³	+	12 x 10 ³	+	190 x 10 ³	+	(11)	12 x 10 ³ ±	
1.5	12 x 10 ³	+	2 x 10 ³	+	25 x 10 ³	+	(33)	2 x 10 ³ +	
2.0	12 x 10 ³	+	2 x 10 ³	+	1 x 10 ³	+	(33)	1 x 10 ³ +	
<i>Experiment 2. Preservation system — Na₂SO₃ and NaHSO₄</i>									
Conc. (%) ‡									
Na ₂ SO ₃	NaHSO ₄								
0	2	1500	+	putrified	—	—	—	—	
0.25	2	50	+	<1 x 10 ³	<1 x 10 ³	+	(17)	440 x 10 ³ +	
0.50	2	180	+	<1 x 10 ³	<1 x 10 ³	+	(23)	74 x 10 ⁶ —	
1.0	2	60	+	<1 x 10 ³	<1 x 10 ³	+	(30)	2 x 10 ³ +	
1.5	2	240	+	<1 x 10 ³	<1 x 10 ³	+	(30)	3 x 10 ³ +	
2.0	0	460 x 10 ³	+	700 x 10 ³	putrified	—	—	—	
<i>Experiment 3. Preservation system — Na₂SO₃ and Acetic Acid</i>									
Conc. (%) ‡									
Na ₂ SO ₃	HOAc								
0	1	3 x 10 ³	+	320 x 10 ³	±	putrified	—	—	
0.25	1	8 x 10 ³	+	1 x 10 ³	+	4 x 10 ³	(24)	42 x 10 ⁶ ±	
0.50	1	1 x 10 ³	+	1 x 10 ³	+	4 x 10 ³	(31)	2 x 10 ³ +	
1.0	1	46 x 10 ³	+	4 x 10 ³	+	1 x 10 ³	(31)	4 x 10 ³ +	
1.5	1	97 x 10 ³	+	—	—	—	(31)	4 x 10 ³ +	

*Samples stored in quart mason jars with treatment solution. + is an acceptable odor, ± indicates a slight off odor, and — indicates a bad or putrid odor.

†0 days indicates a bacterial count made after holding a treated sample approximately one hour.

‡Concentration is based on hide sample weight.

and half percent solutions were ineffective. Microbial counts increased rapidly and by the sixth day these hide samples were putrified. At the one percent level some preservation was achieved, while the 1.5 and 2.0 percent levels provided long-term preservation.

The second experiment in the table demonstrates the preservation effect of various concentrations of sodium sulfite in a solution acidified by the addition of two percent of sodium bisulfate. Short-term preservation was achieved at the quarter percent level and long-term at the one percent sulfite level.

Preservation was not due to bisulfate alone, as it can be seen that in the absence of added sulfite the hide sample putrified within three days. A source of acid is necessary, in this case the bisulfate, as indicated by the poor preservation achieved by two percent sulfite alone.

The third experiment shows that when the acid source was changed to acetic acid under otherwise identical conditions, short-term preservation was attained at the 0.25 percent level of sulfite and long-term at the 0.5 percent level.

All the samples which were checked for bacterial counts in the course of the preservation tests were subjected to a hair saving lime for 72 hrs. After the hair was removed the grain surface was examined for obvious damage, such as holes or pits in the grain. No such damage was noted in any of the samples examined.

The results of these experiments indicate that treating hides with acidified sodium sulfite provides a better preservation than bisulfite alone. It also appears that acetic acid is a better source of acid than the bisulfate to enhance the preservation with sulfite. Acetic acid was also observed to have a further advantage in that the odor of SO_2 is less noticeable in the acetic acid treatments. The pH of treatment solutions containing bisulfate was generally in the range of pH 2 to pH 3. When acetic acid was used, the pH was between 4.5 and 5.0. More sulfur dioxide is evolved at the lower pH. The acetic acid is used at a solution concentration of five percent, which is equal to household vinegar, and this results in a vinegary odor. The odor of both sulfur dioxide and vinegar can be further diminished by increasing the float and by using the lowest possible amount of Na_2SO_3 that is needed to give the desired length of preservation. However, regardless of the acid source, the sulfur dioxide odor is almost completely gone after the hide has been stored for several days, It may be absorbed by the hide substance upon standing.

The most important point shown by this data is that extended short-term preservation and long-term preservation of the hide pieces was demonstrated using the sulfite treatments. Also, short-term preservation can be achieved at the 0.25 percent level of sodium sulfite. The next logical step was to apply these methods to procedures similar to current brine or salt curing practice. The major difference is that salt or brine curing does not require containerization of the hides and the brined hides are allowed to drain.

Effect of Handling Method

The next set of experiments deal with the use of the sulfite treatments on hide samples which were not held in closed containers and which were allowed to drain. A concentration of 1.5 percent sodium sulfite was used so that the results would reflect handling procedures rather than insufficient preservative.

Samples for this series of tests were treated in the plexiglas drum as described in the Materials and Methods section. Half of the samples were allowed to drain individually on stainless steel clips for 30 minutes. The other half were wrung in a hand wringer to remove excess treatment solution. Each group was then divided further. One third were hung over a rod to simulate holding samples on a horse. Each sample was separated from the next by a sheet of polyethylene slightly larger than the sample. Another third were laid flat over a stainless steel wire screen, again each sample separated from the next with a sheet of polyethylene. The rest were held individually in unsealed polyethylene bags. The results of this test using sodium bisulfate as the acid source are shown in Table II.

TABLE II
THE EFFECT OF VARIOUS STORAGE METHODS ON TREATED
HIDE PIECES AS JUDGED BY BACTERIAL COUNT*

Storage Time (Days)	Treatment — 1.5% Na ₂ SO ₃ + 2% NaHSO ₄					
	Storage Method					
	Horsed		Flat		Bagged	
	Wrung	Drained	Wrung	Drained	Wrung	Drained
3	g†	g	g	g	g	g
6	ng	ng	ng	ng	ng	ng
8	ng	g	ng	g	ng	g
10	g	g	g	g	ng	ng

*Samples were black steerhide which was demanured and fleshed.

†g = good; indicates <20,000 bacteria per gram of hide.

ng = not good; indicates >20,000 bacteria per gram of hide.

The result of each individual test is recorded in the table as good (g) or not good (ng). It was arbitrarily decided that if the count was less than 20,000 bacteria/gram of hide, the preservation was good. If the number of bacteria was above this limit, the preservation was considered to have failed. This is a severe restriction since fresh hides before treatment typically contain from 100,000 to 400,000 bacteria per gram of hide and even salt cured hides consistently were found to contain over 500,000 bacteria per gram.

The results of the test were inconclusive. Preservation was slightly better on those samples that were horsed or stored flat and whose edges were exposed to

the air and dehydrated. While the dehydration slightly improved the preservation, the horsed samples became so dry and crusty on the edges that it would make these samples difficult to wet back. Wringing seemed to reduce the length of the preservation.

When the procedure was repeated with acetic acid as the acid source, the horsed samples were omitted because they had become so dry in the previous run. Table III shows the preservation was slightly improved; however, even in as

TABLE III
THE EFFECT OF VARIOUS STORAGE METHODS ON TREATED
HIDE PIECES AS JUDGED BY BACTERIAL COUNTS*

Treatment — 1.5% Na ₂ SO ₃ + 1.0% HOAC				
Time (Days)	Storage Method			
	Flat		Bagged	
	Wrung	Drained	Wrung	Drained
3	g†	g	g	g
6	g, g	g, g	g, g	g, g
9	ng, ng	g, g	g, ng	g, ng

*Samples were black steerhide which was demanured and fleshed.

†g = good; indicates <20,000 bacteria per gram of hide.

ng = not good; indicates >20,000 bacteria per gram of hide.

little as nine days failures appeared in both sets of samples. It was apparent that neither of these systems consistently produced good short-term preservation, let alone extended short-term preservation. Sulfite is oxidized in air and loss of preservative by air oxidation might explain the results. The failure of polyethylene bags to hold significantly better may be the result of the thin gauge plastic used being permeable to air.

In any event the preceding results led to a reconsideration of using a more tightly closed system for preservation of samples drained of the preservation solution. In this series the concentration of sulfite was varied and two different floats compared. A plastic container measuring 4 x 6 x 4 inches with a resealable top was used to hold the hide samples. After treating the samples in the plexiglas drum and then draining them for 30 minutes, two samples were placed flesh to flesh in each container. Even with this draining period, residual draining of treatment solution amounting to from ten to 20 percent of the sample weight appeared in the bottom of the containers during storage. At the end of storage, the samples were removed for bacterial counts.

Using two percent bisulfate as the acid source, the data in Table IV show that all samples were preserved for 12 days. After that period, the preservation was

not consistent. There was no apparent difference due to either sulfite concentration or the level of the float.

The series was repeated with acetic acid (Table V); it was again apparent that acetic acid is the more effective adjunct to sulfite. Both the lower concentra-

TABLE IV
THE EFFECT OF SULFITE CONCENTRATION AND FLOAT ON
PRESERVATION OF HIDE PIECES AS JUDGED BY BACTERIAL COUNTS*

Time (Days)	Treatment (X)% Na ₂ SO ₃ + 2% NaHSO ₄		
	20% Float		10% Float
	(X) = 1.0% Na ₂ SO ₃	(X) = 1.5% Na ₂ SO ₃	(X) = 1.5% Na ₂ SO ₃
2	g†	g	g
5	g	g	g
9	g	g	g
12	g	g	g
16	g	ng	ng
19	ng	ng	g
23	g	g	ng
28	ng	ng	ng

*Samples were black steerhide which was demanured and fleshed. After treatment the samples were drained and then stored in sealed plastic boxes.

†g = good; indicates <20,000 bacteria per gram of hide.

ng = not good; indicates >20,000 bacteria per gram of hide.

TABLE V
THE EFFECT OF SULFITE CONCENTRATION AND FLOAT ON
PRESERVATION OF HIDE PIECES AS JUDGED BY BACTERIAL COUNTS*

Time (Days)	Treatment (X)% Na ₂ SO ₃ + 1.0% HOAc		
	20% Float		10% Float
	(X) = 1.0% Na ₂ SO ₃	(X) = 1.5% Na ₂ SO ₃	(X) = 1.5% Na ₂ SO ₃
2	g†	g	g
5	g	g	g
9	g	g	g
12	g	g	g
16	g	g	g
19	g	ng	g
23	g	ng	g
28	g	ng	g

*Samples were black steerhide which was demanured and fleshed. After treatment samples were drained and then stored in sealed plastic boxes.

†g = good; indicates <20,000 bacteria per gram of hide.

ng = not good; indicates >20,000 bacteria per gram of hide.

tion of sulfite and the lower float preserved the samples for the full 28 days. The data presented in Tables IV and V demonstrate that sulfite preservation has potential for eliminating the use of salt for hide preservation.

However, it is not sufficient only to inhibit or retard growth of microorganisms on the hides. The resulting leather must be of good quality.

Effect of Treatment on Leather Quality — Matched Side Experiment

A matched side experiment was run as previously described to compare the quality of leather made from acid sulfite treated hides with that from commercially brined hides. The treatment solutions were one and one half percent sodium sulfite, 0.03 percent Tergitol, and the acid source, all in a twenty percent float. With three of the sides one percent acetic acid was used as the acid source and with the other three two percent sodium bisulfate was used.

After holding for six days at ambient temperature, the sides were taken to a tannery to be made into upholstery leather. Evaluation of the preservation was made by examining the leather in the crust stage.

Table VI shows the effectiveness of the preservation treatments on the matched sides in terms of bacterial count per gram of hide. The microbial counts of the treated sides were considerably lower than those of the brined hides. The bisulfate acidified sides initially had an odor of sulfur dioxide, which was no longer noticeable after storage for six days. The acetic acid acidified sides smelled vinegary even after storage.

TABLE VI

BACTERIAL COUNTS ON MATCHED SIDES COMPARING BRINED SIDES AND ACID SULFITE TREATED SIDES AFTER SIX DAYS OF STORAGE*

Treated Side		Brined Side	
1.5% Na ₂ SO ₃ + 1.0% HOAc or 2.0% NaHSO ₄			
Side	Bact./gm. Hide	Side	Bact./gm. Hide
	(2.0% NaHSO ₄)		
1A†	1,000	1B	1,150,000
2A	16,000	2B	612,000
3A	2,000	3B	1,000,000
	(1.0% HOAc)		
4A	6,000	4B	846,000
5A	5,000	5B	547,000
6A	53,000	6B	635,000

*Matched sides from demanured, fleshed, black steerhides. The treated sides were drained in the drum for 15 minutes and then stored in covered plastic containers at ambient temperatures. The brining was done commercially in a raceway.

†A and B — matched side groupings.

The general evaluation of the leather by the tanner was that the leather made from the treated sides was equal to or better than the leather made from the brined controls. All the leathers were considered a little loose, whether brined or treated. In terms of tensile strength (Table VII) there was little difference between the experimental and control leather.

TABLE VII
A MATCHED SIDE COMPARISON OF THE TENSILE STRENGTHS OF
LEATHER PREPARED FROM BRINE CURED AND
ACID SULFITE TREATED HIDES

	Brined			Treated		
	Elong. (%)	Load (lb.)	Tensile* (p.s.i)	Elong. (%)	Load (lb.)	Tensile* (p.s.i)
<i>Treatment: 2 percent NaHSO₄, 1.5 percent Na₂SO₃ in a 20 percent float</i>						
Sample I†	41	103	2935	48	93	2425
Sample II	42	127	3680	46	134	3885
Sample III	52	126	3285	50	112	3220
<i>Treatment: 1 percent acetic acid, 1.5 percent Na₂SO₃ in a 20 percent float</i>						
Sample I	46	95	2605	38	93	2635
Sample II	47	77	2155	50	88	2510
Sample III	53	92	2485	50	101	2855

*The tensile strength was determined parallel to the backbone. Each figure is an average of three values.

†Each sample is a matched brined and treated side.

Treatment Costs

Cost considerations are important. An overall cost figure for the sulfite process can only be estimated but it does not appear to be prohibitive. A comparison of material costs is shown in Table VIII. While chemical costs can be determined, equipment and handling costs can only be estimated. Preservation with sulfite will probably require some type of containerization. This will add to the cost of handling hides but some of this increase will be offset by reducing individual hide handling. An additional cost advantage of containerization is that the hides are protected from damage due to excessive handling and further contamination. Cost balance at this time does not seem to be unfavorable but a more extensive analysis needs to be done in this area.

At this stage large-scale studies are necessary further to test this process under industrial conditions to evaluate leather produced from hides preserved with acid sulfite. If the results of these trials are satisfactory, actual implementation of the process may cause some problems to packer and tanner alike. The introduction

TABLE VIII
A COMPARISON OF THE COSTS OF MATERIAL FOR SALT
AND SULFITE TREATMENTS ON 100 LBS. FRESH HIDE

A. Salt		
Brine Cure (NaCl)	33 lbs. @ \$1.99/cwt.*	65.7¢
<i>Total Chemical Costs:</i>		65.7¢
B. Sulfite Treatments		
1% Na ₂ SO ₃	1 lb. @ \$11.00/cwt.	11.0¢
1% Acetic Acid	1 lb. @ \$15.50/cwt.	15.5¢
2% NaHSO ₄	1 lb. @ \$2.75/cwt.	5.5¢
<i>Total Chemical Costs:</i>		
	Sulfite and acetic	26.5¢
	Sulfite and bisulfate	16.5¢

*Costs based on prices reported in *Chemical Marketing Reporter*, May 19, 1975.
Data on costs were updated in proof.

of a new product into an established marketing situation always produces problems. However, since effluent solids from tannery and packinghouses must be reduced or eliminated, the sulfite process appears to be a readily available alternative to salt or brine curing.

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DISCUSSION

DR. WILLIAM C. PRENTISS (Rohm and Haas Company): Dr. Bailey, we very much appreciate this contribution to our technical program, and present to you this certificate of award on behalf of the American Leather Chemists Association. The discussion of this paper will be led by Mr. Satyendra Mohan De of Chestnut Operating Company.

MR. DE: Dr. Bailey's paper is very interesting, especially when the tanners and the hide curing plants are concerned about the future pollution problem due to sodium chloride. I think that Dr. Bailey has presented some interesting data which may indicate lessened future problems. However, I do not know whether the method will be suitable for storage of the hides in the tannery. As we know, tanners must sometimes hold their hides in storage before they can use them. Another point which Dr. Bailey mentions is that tanners may have to change their beamhouse processes. I would like to ask Dr. Bailey what beamhouse changes he might suggest?

DR. BAILEY: I have some ideas on this and we will be working on ways to improve the leather quality. We think perhaps a longer soak may be needed, but that is purely speculative. I don't expect a major beamhouse change will be necessary.

MR. DE: Are there questions from the floor?

MR. ROBERT M. REIHSMANN (Arthur C. Trask Corporation): Concerning your study of microbial growth, you said that you washed the hide specimens. I wonder if there was any microbial growth within the hide which might cause the looseness which the tanner noticed?

DR. BAILEY: We shook the hide specimens with the wash water for 15 minutes. I believe that if there was any growth within the hide we would have seen it. Our break-off point of 20,000 bacteria per gram is pretty low. I would say that there are very few bacteria within the hide.

DR. PETER R. BUECHLER (PPG Industries, Inc.): We may be placing too much emphasis on the looseness, since you said that the matched brined sides were also loose.

DR. BAILEY: I guess that is one of the values of the matched side technique. I would have expected the brined sides to have turned out well. Hence, it may be a problem of the hides used and not the treatment.

MISS BETTY M. HAINES (British Leather Manufacturers' Research Association): We are particularly interested in this subject and have been looking at short-term preservation of hides and skins for some time, especially considering sheepskins. One skin source has been using metabisulfite mixed into the curing salt (one percent level on the salt used) to prevent red heat growth. He has been doing this very successfully for three years on sheepskins. During your laboratory storage, what was the temperature of storage?

DR. BAILEY: They were at ambient temperature.

MISS HAINES: We store our laboratory samples at 26°C., equivalent to the warmer summer days in England, with a goal of five to ten days stability. We

were able to hold sheepskins for 12 days with a 20 percent solution of sodium chlorite sprayed upon the skin surface. I think that you should look at suede leather since it is a very sensitive material. If you get any influence from the short-term preservative on the leather dyeing characteristics (which you must consider if the temporary preservation is to be acceptable) you will see it very quickly on suede leather, along with the harshness of the suede nap. This is the reason that prevented the use of concentrated sodium chlorite solutions some years ago, because the skins were unusable because of the harsh nap, I think because of the crosslinking of the collagen by the chlorite. I think that it would be useful to do histological examinations as well as bacterial counts. We have found that acetic acid loosens the epidermis and hair. If you get hair slip that is not bacterial, this could contribute to the looseness.

DR. BAILEY: The hair is loosened, but we do not think that is bacterial in origin. It may be the acetic acid.

MR. HERBERT A. TETREAU (Rohm and Haas Company): Did you say that the chemical cost for the standard brine curing was 47.2 cents per 100 pounds of fresh hides?

DR. BAILEY: Yes, I used *Chemical Marketing Weekly* costs in the estimate. Actual costs will vary, of course.

MR. TETREAU: It seems to me that several years ago the USDA put out a bulletin on brine curing of hides, and I thought that they estimated the cost at 15 cents.

DR. BAILEY: My basis for estimation is current CMW prices for salt, as well as the other chemicals used.

MRS. JEAN TANCOS (Tanners' Council Research Laboratory): Did you observe any mold growth under your acidic conditions?

DR. BAILEY: With the very lowest levels of sulfite, where the samples are not stable, usually the first growth we observe is mold. Acetic acid alone will hold the hides very well for three days, but almost predictably on the fourth day mold growth will be seen. We think that five percent acetic acid alone might be very effective for a short three-day preservation.

MR. DE: Thank you, Dr. Bailey for this very interesting paper.