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Biochemical Research Laboratory

The Dow Chemical Company

SUITABILITY OF METHYL CHLOROFORM AND METHYLENE CHLORIDE FOR USE IN AEROSOL HAIR SPRAY FORMULATIONS

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Signed K. J. Olson, June 20, 1966

Checked D. D. McCollister, June 22, 1966

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Ethane: 1,1,1-trichloro-, in hair spray formulation

Methane: dichloro-, ©

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R&S168054

SUITABILITY OF METHYL CHLOROFORM AND METHYLENE CHLORIDE FOR USE IN AEROSOL HAIR SPRAY FORMULATIONS

Biochemical Research Laboratory

The Dow Chemical Company

Midland, Michigan

June 1, 1966

I. INTRODUCTION

The purpose of this study was to evaluate the toxicological properties from inhalation, eye irritation, and skin irritation viewpoints of several proprietary hair sprays in comparison with Dow Experimental Formulations containing methyl chloroform and methylene chloride in varying concentrations. Nitrous oxide was also evaluated as a propellant. Vinyl chloride was incorporated in two of the experimental formulations.

II. GENERAL SUMMARY AND CONCLUSIONS

A. All Dow experimental formulations studied produced some degree of corneal injury as a result of direct spray applications to the rabbit eye. In general the effects were comparable to those produced by the proprietary products. The formulations would likely not produce permanent effects in the human eye.

B. None of the Dow or proprietary formulations studied would be likely to produce skin irritation under conditions of recommended use.

C. Laboratory rats exposed to approximately 800 times the atmospheric concentration of aerosol mist and vapor that would result under consumer use conditions showed signs of toxicity, including death, which was attributable to suffocation resulting from oxygen depletion. It is most unlikely that any untoward effects would result from normal use of any of the formulations tested.

D. It is recommended that formulations containing vinyl chloride be subjected to further study in order to insure safety.

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III. MATERIALS AND FORMULATIONS TESTED

A. Proprietary Products

Proprietary Product	Trade Name	Manufacturer
1	New Lustre Cream	Colgate-Palmolive
2	Super Natural	Reylon, Incorporated
3	Alberto VO5	Alberto-Culver Company
4	Breck	Breck
5	Sudden Beauty	Whitehall Laboratories
6	Just Wonderful	Caryl Richards, Inc.
7	New Halo	Colgate-Palmolive Co.
8	Hidden Magic	Proctor and Gamble
9	Spray Net	Helene Curtis Ind.
10	Aqua Net	Helene Curtis Ind.
11	Adorn	Toni Co. (Gillette)

B. Dow Experimental Formulations (Percentages)

	F-12	Vinyl Chloride	F-11	Methyl Chloroform	Methylene Chloride	Resin PVP/VA	Ethanol	Nitrous Oxide (60 psig)
1	25		25			2.5	47.5	
2	25			25		2.5	47.5	
3	25			15	10	2.5	47.5	
4	15			50		2.5	30.0	2.5
5	15			40	10	2.5	30.0	2.5
6		15		50		2.5	30.0	2.5
7		15		40	10	2.5	30.0	2.5
8	15			40		2.5	40.0	2.5
9	15			30	10	2.5	40.0	2.5
10	25		15		10	2.5	47.5	

F-12, F-11 from DuPont

Vinyl chloride, methyl chloroform (tech.), and methylene chloride (tech.) all from Dow.

Ethanol is anhydrous formula 40-2

PVP/VA from General Aniline and Film Corporation 60:40 ratio

IV. INHALATION OF AEROSOL MIST

A. General Comment

As a result of extensive studies which have been conducted in the laboratory and also judging by human exposure experience from manufacturer and customer use it is known that the toxicity of the solvents (methyl chloroform and methylene chloride) used in the Dow formulations is very low. In light of this knowledge it was recognized that in order to assess any possible toxicological effects which might result from exposure to hair spray mist, a laboratory method would have to be devised which would afford drastic exposure conditions to laboratory animals.

The method described below was designed with the intent of providing atmospheric concentrations of the mist and vapor just slightly below that which would produce death in laboratory rats caused by asphyxia or suffocation. In other words, the oxygen level in the exposure chamber as a result of vapor and mist displacement would be barely sufficient to support life.

B. Laboratory Method

A total of 138 rats (69 males and 69 females) were used on the experiment. Young male rats were chosen in the weight range of 170-300 grams. The female rats weighed between 140-190 grams. The exposure chamber consisted of a wire mesh cage, 7" x 7" x 14" in dimensions, which was enveloped in a polyethylene bag secured tightly to the walls of the cage with tape. Six rats (three males, three females) were placed in the chamber immediately prior to the exposure. The aerosol can was then introduced into the neck of the bag and the aerosol mist was delivered directly into the chamber for exactly ten seconds. The bag was then sealed and the animals were allowed to remain in the air-tight chamber for an exposure period of fifteen minutes. At the termination of the experimental period the plastic bag was removed from the cage, the animals were then returned to holding cages where they were allowed to eat and drink ad libitum. This procedure was repeated three times per day (10:00 A.M., 1:00 P.M., and 4:00 P.M.) five days per week for two weeks. The exposure amounted to 45 minutes per day or a total exposure time of 450 minutes (7.5 hours) over the two week period.

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All animals were observed daily during and after the exposure period for signs of untoward physiological responses, abnormal behavior or stress of any kind. During the two week experimental period all animals were weighed three times per week. Animals which failed to survive the procedure were autopsied, when practical, to determine the cause of death.

At the end of the two week period all surviving animals were sacrificed and internal organs were examined from a gross pathological viewpoint. At the sacrifice time, blood samples were taken for the purpose of determining serum urea nitrogen (SUN) and glutamic pyruvic transaminase values (SGPT) in the serum. Serum urea nitrogen is reported as mg.% and SGPT in units/ml. An enzyme unit is defined as the amount of enzyme which catalyzes 1 mμ mole change of reactants per minute at 37°C and pH 7.4.

The volume of the exposure chamber was 784 cu. in. or approximately 12.8 liters. The total volume occupied by the six rats was calculated to be 1.8 liter. The unoccupied volume of the experimental chamber, therefore, was about 11 liters. Assuming uniform dispersion of mist, the animals, then, were exposed to about 815 times the atmospheric concentration of hair spray ingredients that would be encountered in normal human use in a powder room of dimensions of 5' x 8' x 8' (320 cu. ft. or 8900 liters).

In addition to concentration differential it should be appreciated that a powder room is subjected to some degree of ventilation which would afford a continuous dilution factor in the case of human use. The rat exposure chamber was air-tight.

C. Results and Conclusions

From inspection of the mortality ratio data presented in Table 1 it is apparent that several animals failed to survive the drastic exposure conditions imposed by the test procedure. Dow Sample 6 which contained 50% methyl chloroform and 15% vinyl chloride afforded the highest mortality ratio as none of the six rats exposed survived. Four of these animals died following the very first exposure. In the case of Dow Sample 4 which contained 50% methyl chloroform and 15% Freon-12, only half of the animals (all females) survived.

Attention is called to the data recorded for Dow Sample 1 (control) which contained Freons 11 and 12. While there

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was no mortality in the Dow Sample 1 Control group, half of the animals gained weight and half lost. In the case of the air controls, all animals except one showed a normal weight gain pattern. The mortality data pertaining to the remaining Dow experimental materials is not appreciably different from those of the proprietary materials. From gross pathological examination of deceased animals, death was attributed to suffocation resulting from oxygen displacement by the excessive mist in the exposure chambers.

Serum urea nitrogen values (Table 2) were normal in all animals at the time of sacrifice. SGPT values (Table 2) were likewise judged normal except for two questionably high values; one animal of three on Proprietary 5 and one of three on Proprietary 8.

It is apparent from the data presented that the major physiological effect caused by exposing rats to aerosol hair spray mist was that resulting from oxygen depletion in the atmosphere. In view of the fact that the exposure concentration of mist approximated 800 times that likely to be experienced by humans, it is very unlikely that any untoward effects would result from normal use of any of the proprietary or experimental formulations. There appears to be no contra-indication for the use of methyl chloroform and methylene chloride in any of the combinations studied. Due to the results for Dow Sample 6 it is recommended that vinyl chloride not be considered for use in aerosol hair sprays until further investigated for this use in the laboratory. The highly acute effects (death) appear to have resulted from suffocation. Vinyl chloride has a very high vapor pressure and would be expected to rapidly contribute to oxygen depletion in such extremely confined quarters.

V. EYE IRRITATION (TABLE 3)

A. Method

Three albino rabbits were used to evaluate eye irritating properties of each hair spray formulation. Prior to conducting the study, all eyes were established as being free of injury when the corneal tissue showed no response to aqueous fluorescein stain. The materials were sprayed directly into the conjunctival sacs by holding the spray nozzle 4 to 6 inches from the eye. The amount of material actually entering the conjunctival sac was regulated by the time required for the animal to blink, which was

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almost instantaneous in spite of an attempt by an attendant to hold the eye open. In no case were the materials washed from the eyes. Immediately following the application, the exposed eyes were examined for signs of conjunctival irritation and corneal injury. The eyes were subsequently examined at intervals of one hour, twenty-four hours, forty-eight hours, one week and two weeks after instillation of the material. Here again, fluorescein stain was employed to assist in detecting corneal injury. The type and intensity of the reaction were rated according to the following index code.

Index	Reaction
1	No effect.
2	Very slight effect disappearing in 24 hours. May consist of appreciable pain initially and some conjunctival irritation. No corneal injury.
3	Slight effect, disappearing within a week. May consist of appreciable conjunctival irritation and pain but no corneal or internal injury.
4	Moderate effect consisting of superficial corneal injury which cleared within a week. No loss of vision expected. Conjunctival irritation may or may not be severe.
5	Moderate to severe effect, consisting of corneal injury from which recovery will be prolonged. Some iritis may be observed. Permanent impairment of vision not likely.
6	Severe effects consisting of total loss of vision due to serious corneal injury and/or internal involvement.

B. Results and Conclusions

In Table 3 (bar graph) it will be noted that the eye reactions of each individual animal are recorded. It is further important to note that each formulation, Proprietary as well as Dow Experimental, is compared with the control formulation (Dow Sample 1), for each individual animal. The length of the line is indicative of the degree of eye tissue reaction and in each case should be compared with the control dotted line. The length of the dotted lines vary considerably and reflect for the most part animal variation with respect to eye tissue reaction to the spray mist.

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In general, all of the formulations studied except two (Proprietaries 1 and 8) produced some degree of corneal injury when sprayed directly into the rabbit eye. While there are individual rabbits in which the experimental or proprietary formulation appears less irritating than the control, if an attempt is made to average the reactions of the three animals used on any particular formulation in all cases except two (Proprietaries 1 and 8) the experimental or proprietary material is as toxic or more toxic as an eye irritant than the control. Even the most severe reactions produced in the rabbits are deemed not of a permanent nature. Considering the limits of animal variation and the limited number of animals employed on the study, it would be risky to attach much significance to proclaiming safety of one formulation over another, particularly where hazard relative to normal consumer use is the major consideration.

The chemical exposure in these experimental studies was accomplished by holding the rabbit eye open which represents a much more extensive eye contamination than would likely occur incidental to spraying the hair. In addition to this, most investigators feel that the human cornea is appreciably more resistant to chemical irritation than is the rabbit cornea. In the opinion of the writer, none of the experimental Dow formulations would be expected to produce permanent effects in the human eye.

VI. SKIN CONTACT IRRITATION

The laboratory procedure was designed to evaluate irritation potential of the hair spray formulations when applied under simulated use conditions as well as under conditions of exaggerated or rather drastic exposure.

A. Method

Three albino rabbits were employed on each formulation. Several days prior to starting the study, the hair was removed from the belly skin using a straight razor and barber soap. All animals were caged individually and allowed to eat and drink ad libitum throughout the experimental period of two weeks. The formulations were evaluated for irritation potential by applying the spray mist to the inner surface of the ear and to intact and abraded skin of the belly. In order to simulate the drastic exposure condition, the abdominal areas were fitted with a cloth bandage taped securely in place. This served to suppress evaporation and to render the

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material capable of exerting its maximum irritation effects. The application to the ear (unbandaged) served to more closely simulate use conditions. The materials were applied in the form of the spray mist to all exposure sites by holding the nozzle 4-6 inches from the skin surface and releasing the spray for 2-3 seconds. This procedure delivered an excessive amount of liquid concentrate to each exposure site. Fresh amounts were applied each day to each site; five days per week for two weeks to the ear and intact belly skin and for three consecutive days to freshly abraded skin. In the case of the intact areas, the test program represented continuous exposure for 14 days. The continuous exposure in the case of abraded skin was of three days' duration. The condition of the skin was assessed and the severity of the response was recorded 24 hours after each application. The animals were weighed at intervals during the exposure period and were observed frequently to detect any departure from normal insofar as general appearance and behavior were concerned.

The estimated average response of the three animals employed is recorded in Table 4 for each formulation following application. The numerical rating code is as follows.

Index	Reaction
1	No perceptible reactions.
2	Questionable to barely perceptible erythema and/or exfoliation.
3	Definite but slight erythema and/or exfoliation. No burn.
4	Slight or moderate erythema and/or exfoliation with slight or moderate superficial skin burn. Healing of abrasions normal. Slight scar may or may not result.
5	Moderate to severe skin reaction including deep burn resulting in appreciable scar formation.
6	Extensive skin injury including impairment of healing. Extensive scar formation likely.

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B. Results and Conclusions

All materials studied, when sprayed in copious amounts to the inner surface of the rabbit ear and allowed to remain for 24 hours, produced essentially no perceptible skin reaction. In all cases, continuous response to the ear for up to ten days produced only a slight perceptible erythema and/or exfoliation. In this regard all materials appear to possess the same properties as the control (Dow Sample 1) insofar as skin irritation potential is concerned. When intimately confined under a bandage to intact skin (rabbit belly) for 24 hours, the materials produced, at the most, a slight erythema.

These data represent results of skin exposure far in excess of what would likely occur under normal use of hair sprays. The Dow experimental formulations are comparable to the control (Dow Sample 1) and to several of the proprietary materials. None appeared to impair healing of freshly abraded skin.

When confined to skin on a continuous basis for several days, Dow Sample 6 appeared to possess the greatest potential for irritating the skin of all formulations studied. After five days it produced a moderate to severe burn. Similar exposure resulted in superficial burns in the case of Dow formulations 4, 5, 7, and 8. It should be appreciated that under this condition of exposure solvent evaporation is greatly inhibited and that such conditions in no way resemble those of normal use.

In the opinion of the writer, there are no contra-indications, from a skin irritation viewpoint, for further investigating the usefulness of the solvent systems represented by the Dow experimental formulations in hair spray preparation.

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Table 1 - INHALATION OF HAIR SPRAY MIST (RATS)

Material	No. Of Exposures (3/day)	Exposure Time min/day	Exposure Time Total min	Total Weight Material Used (grams)	No. Of Rats	Sex	No. Died/ No. Exposed	Av. Wt. Change Of Survivors (grams)	Response-Remarks
Proprietary 1	30	45	450	350	3	M	1/3	+ 7.5	Animal died after 6 exposures (2 days)
					3	F	1/3	- 5.0	Animal died after 9 exposures (3 days)
Proprietary 2	30	45	450	234	3	M	1/3	+12.0	Animal died after 12 exposures (4 days)
					3	F	1/3	- 3.0	Animal died after 9 exposures (3 days)
Proprietary 3	30	45	450	254	3	M	1/3	+14.0	Animal died after 9 exposures (3 days)
					3	F	0/3	- 2.5	
Proprietary 4	30	45	450	214	3	M	0/3	+14.3	
					3	F	0/3	- 1.3	1 rat gained 2 g., the others lost 5 g. and 1 g.
Proprietary 5	30	45	450	276	3	M	0/3	+ 9.5	1 rat lost 1 g., the others gained 18 g. and 2 g.
					3	F	0/3	-26.7	Animals lost 9, 26 and 45 g.
Proprietary 6	30	45	450	289	3	M	0/3	+17.4	Animals gained 13, 16 and 23 g.
					3	F	0/3	- 2.0	One animal gained 3 g., the others lost 3 and 6 g.
Proprietary 7	30	45	450	350	3	M	0/3	-16.0	One rat gained 1 g., the others lost 11 g. and 38 g.
					3	F	0/3	-19.7	Animals lost 1, 13 and 45 g.

continued

Table 1 - continued

Material	No. Of Exposures (3/day)	Exposure Time min/day	Exposure Time Total min	Total Weight Material Used (grams)	No. Of Rats	Sex	No. Died/ No. Exposed	Av. Wt. Change Of Survivors (grams)	Response-Remarks
Proprietary 8	30	45	450	321	3	M	1/3	- 2.0	Animal died after 6 exposures (2 days), one rat gained 2 g., the other lost 24 g.
					3	F	0/3	+ 9.4	Rats gained 1, 7 and 20 g.
Proprietary 9	30	45	450	365	3	M	0/3	-21.4	Rats lost 14, 20 and 30 g.
					3	F	0/3	-11.0	Rats lost 9, 12 and 12 g.
Proprietary 10	30	45	450	221	3	M	0/3	- 9.4	Rats lost 5, 11 and 12 g.
					3	F	0/3	- 4.4	Two rats lost 3 and 13 g.; one gained 3 g.
Proprietary 11	30	45	450	234	3	M	0/3	-22.7	Rats lost 16, 24 and 28 g.
					3	F	0/3	-12.7	Rats lost 12, 13 and 13 g.
Air Control	30	45	450	---	3	M	0/3	+20.4	Rats gained 14, 23 and 24 g.
					3	F	0/3	+ 5.4	Two rats gained 11 and 19 g.; one lost 14 g.
Dow Sample 1 (control)	30	45	450	209	3	M	0/3	+15.7	Two rats gained 15 and 40 g., one rat lost 8 g.
					3	F	0/3	-13.0	Two rats lost 8 and 9 g., one rat gained 4 g.
Dow Sample 2	30	45	450	196	3	M	1/3	-15.7	Rats lost 15 and 32 g.
					3	F	0/3	-12.7	Rats lost 7, 15 and 16 g.

continued

Table 1 - continued

Material	No. Of Exposures (3/day)	Exposure Time min/day	Exposure Time Total min	Total Weight Material Used (grams)	No. Of Rats	Sex	No. Died/ No. Exposed	Av. Wt. Change Of Survivors (grams)	Response-Remarks
Dow Sample 3	30	45	450	198	3	M	0/3	-27.7	Rats lost 19, 24 and 30 g.
					3	F	1/3	-14.0	Rats lost 13 and 15 g.
Dow Sample 4	30	45	450	221	3	M	3/3		Animals died after 3 exposures (1 day)
					3	F	0/3	- 7.0	Animals lost -3, -9 and -11 g.
Dow Sample 5	30	45	450	246	3	M	1/3	- 9.0	One rat gained 3 g.; one lost 30 g.
					3	F	1/3	-13.0	Animals lost 12 and 14 g.
Dow Sample 6				129			3/3		Two males and two females died following very first exposure. Others died on fourth and seventh day of the experiment.
Dow Sample 7	30	45	450	212	3	M	1/3	-10.4	Rats lost 12 and 19 g.
					3	F	1/3	- 5.0	Rats lost 6 and 9 g.
Dow Sample 8	30	45	450	228	3	M	1/3	-22.0	Rats lost 20 and 24 g.
					3	F	1/3	-14.5	Rats lost 12 and 17 g.
Dow Sample 9	30	45	450	218	3	M	0/3	-17.7	Rats lost 5, 20 and 27 g.
					3	F	3/3	--	
Dow Sample 10	30	45	450	205	3	M	1/3	-12.0	Rats lost 9 and 15 g.
					3	F	0/3	-10.0	Rats lost 7, 11 and 12 g.
Air Control	30	45	450	---	3	M	0/3	-12.7	Two rats lost 11 and 29 g.; 1 gained 2 g.
					3	F	1/3	- 5.5	Rats lost 5 and 6 g.

Table 2 - SERUM BLOOD UREA NITROGEN (BUN) AND SERUM GLUTAMIC PYRUVIC TRANSAMINASE (SGPT) VALUES ON RATS EXPOSED TO HAIR SPRAY MIST

Material	Males			Females		
	Animal Number	BUN (Mg. %)	SGPT (units/ml.)	Animal Number	BUN (Mg. %)	SGPT (units/ml.)
Untreated (controls)	1	23	84.9	4	19	64.6
	2	17	47.8	5	21	59.8
	3	14	70.6	6	16	81.3
	Av.	18	67.8	Av.	19	68.6
Air (controls)	2220	18	62.2	2223	21	53.8
	2221	17	57.4	2224	17	51.4
	2222	15	78.9	2225	22	59.8
	Av.	17	66.2	Av.	20	55.0
Proprietary 1	2167	15	57.4	2169	22	40.7
	2168	17	59.8	2170	15	50.2
	Av.	16	58.6	Av.	19	45.5
Proprietary 2	2172	16	87.3	2176	19	45.4
	2173	19	71.8	2177	23	41.9
	Av.	18	79.6	Av.	21	43.7
Proprietary 3	2179	20	64.6	2181	25	41.9
	2180	16	55.0	2183	25	61.0
	Av.	18	59.8	Av.	25	53.4
Proprietary 4	2184	19	51.4	2187	23	40.7
	2185	16	62.2	2188	24	46.6
	2186	17	58.6	2189	20	47.8
	Av.	17	57.4	Av.	22	45.0
Proprietary 5	2190	23	56.2	2193	18	81.3
	2191	19	59.8	2194	15	55.0
	2192	20	83.7	2195	20	105.2
	Av.	21	66.6	Av.	18	80.5
Proprietary 6	2196	18	82.5	2199	19	46.6
	2197	13	56.2	2200	18	46.6
	2198	15	52.6	2201	18	62.2
	Av.	15	63.8	Av.	18	51.8

Continued

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Table 2 - Continued

Material	Males			Females		
	Animal Number	BUN (Mg. %)	SGPT (units/ml.)	Animal Number	BUN (Mg. %)	SGPT (units/ml.)
Proprietary 7	2202	17	64.6	2205	20	45.4
	2203	14	88.5	2206	18	52.6
	2204	17	62.2	2207	18	69.4
	Av.	16	71.8	Av.	19	55.8
Proprietary 8	2208	18	52.6	2211	21	45.4
	2209	18	102.9	2212	19	76.5
				2213	18	53.8
	Av.	18	77.8	Av.	19	58.6
Proprietary 9	2764	18	39.5	2767	24	35.9
	2765	18	39.5	2768	20	32.3
	2766	23	49.0	2769	22	22.7
	Av.	20	42.7	Av.	22	30.3
Proprietary 10	2770	19	29.9	2773	20	19.1
	2771	17	43.1	2774	20	27.5
	2772	19	23.9	2775	20	16.7
	Av.	18	32.3	Av.	20	21.1
Proprietary 11	2776	21	35.9	2779	21	34.7
	2777	23	41.9	2780	25	31.1
	2778	23	41.9	2781	31	39.5
	Av.	22	39.9	Av.	26	35.1
Dow Sample 1 (control)	2214	21	62.2	2217	19	56.2
	2215	17	68.2	2218	20	65.8
	2216	21	69.4	2219	18	39.5
	Av.	20	66.6	Av.	19	53.8
Dow Sample 2	2783	31	44.3	2785	22	38.3
	2784	41	40.7	2786	19	34.7
				2787	20	32.3
	Av.	36	42.5	Av.	20	35.1
Dow Sample 3	2788	14	44.3	2791	20	20.3
	2789	16	50.2	2792	19	29.9
	2790	19	51.4			
	Av.	16	48.6	Av.	20	25.1

Continued

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Table 2 - Continued

Material	Males			Females		
	Animal Number	BUN (Mg. %)	SGPT (units/ml.)	Animal Number	BUN (Mg. %)	SGPT (units/ml.)
Dow Sample 4	NO MALE SURVIVORS			2793	22	34.7
				2794	16	29.9
				2795	21	34.7
				Av.	20	25.1
Dow Sample 5	2796	21	34.7	2798	25	32.3
	2797	23	41.9	2799	27	34.7
	Av.	22	38.3	Av.	26	33.1
Dow Sample 6	NO MALE SURVIVORS			NO FEMALE SURVIVORS		
Dow Sample 7	2800	14	41.9	2802	23	35.9
	2801	19	41.9	2803	20	25.1
	Av.	17	41.9	Av.	22	30.5
Dow Sample 8	2804	18	43.1	2806	21	22.7
	2805	20	95.7	2807	22	34.7
	Av.	19	69.4	Av.	22	28.7
Dow Sample 9	2808	18	51.4	NO FEMALE SURVIVORS		
	2809	18	37.1			
	2810	22	52.6			
	Av.	19	47.0			
Dow Sample 10	2813	17	49	2815	35	
	2814	19	49	2816	26	
				2817	19	
	Av.	18	49	Av.	27	
Air (control)	2818	19	39.5	2821	45	44.3
	2819	21	40.7	2822	34	40.7
	2820	16	39.5			
	Av.	19	39.5	Av.	40	42.5

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Table 3 - THE EFFECTS OF HAIR SPRAY FORMULATIONS WHEN SPRAYED DIRECTLY INTO THE RABBIT EYE

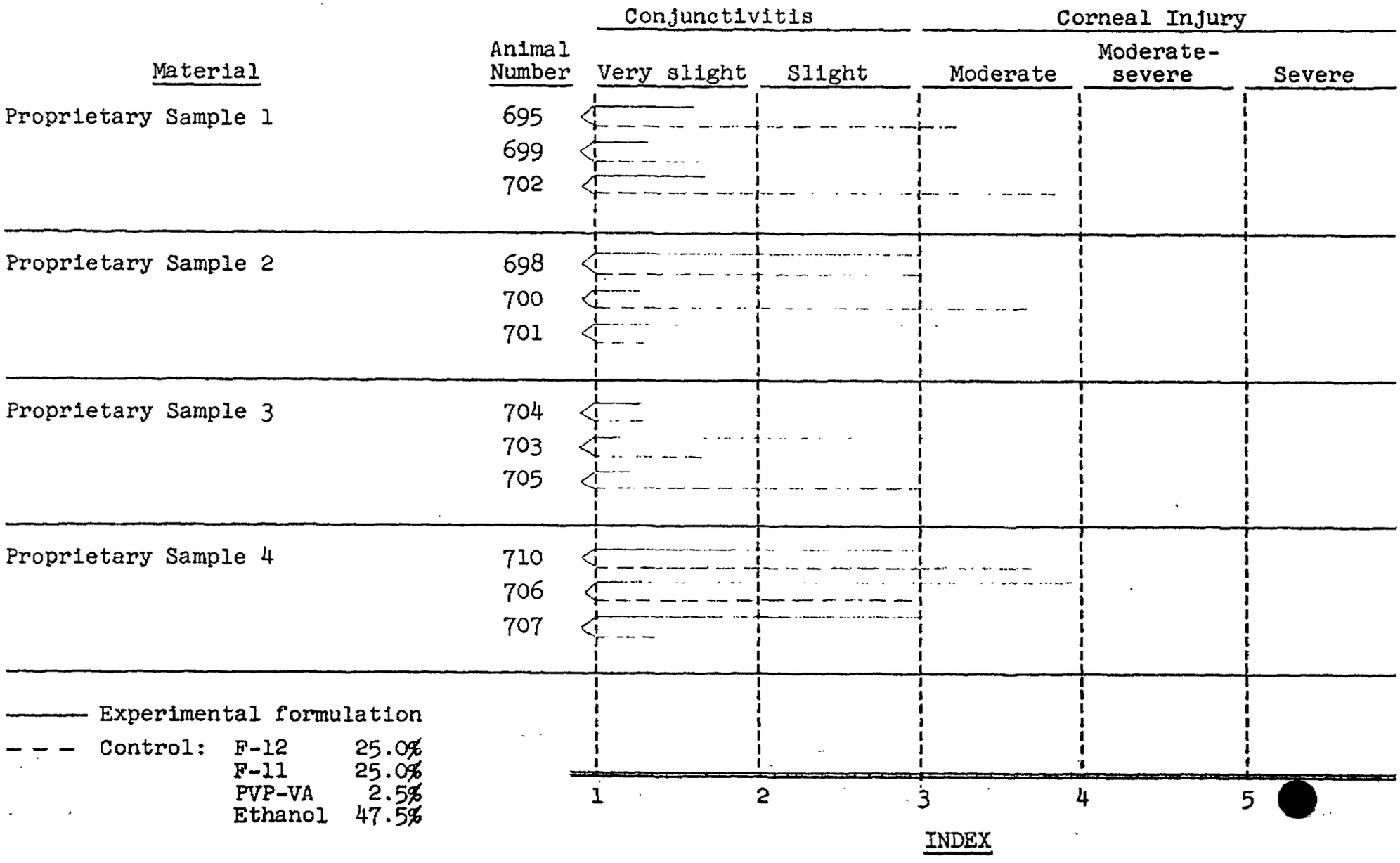


Table 3 - continued

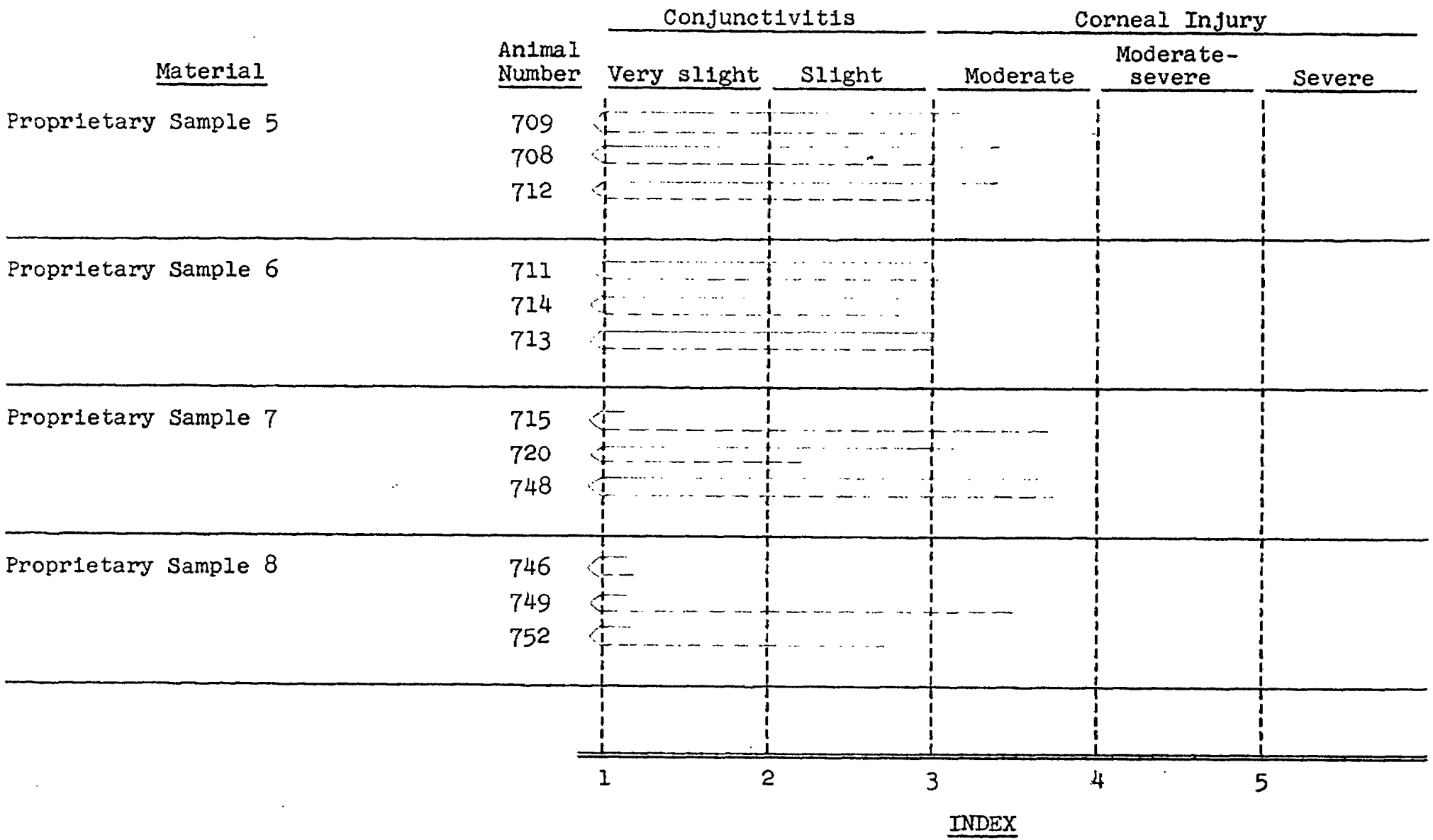


Table 3 - continued

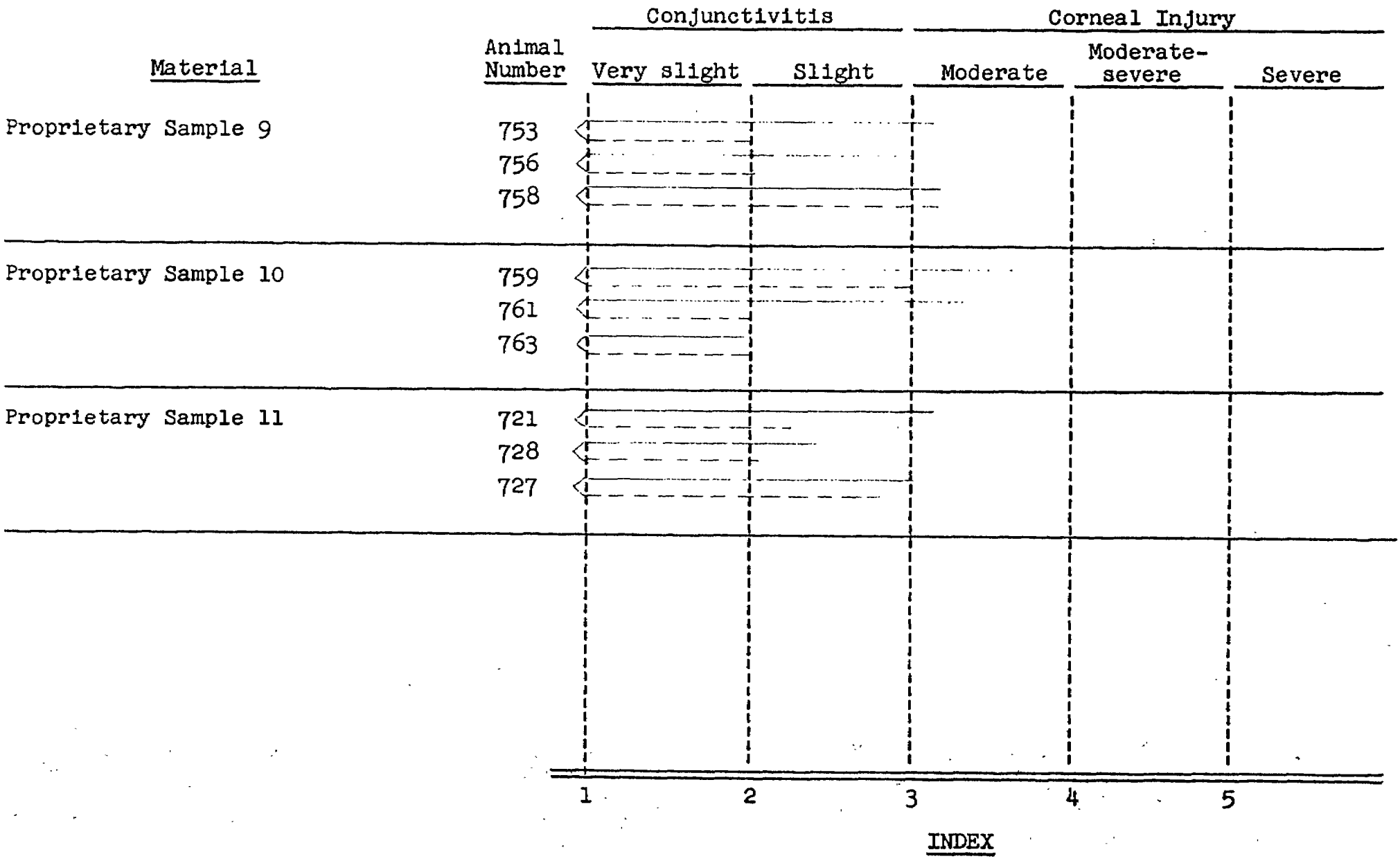


Table 3 - continued

Dow Sample Number	Hair Spray Formulation	(%)	Animal Number
2	Freon-12	25.0	267
	Methyl chloroform	25.0	
	PVP-VA	2.5	263
	Ethanol	47.5	248
3	Freon-12	25.0	281
	Methyl chloroform	15.0	
	Methylene chloride	10.0	245
	PVP-VA	2.5	
	Ethanol	47.5	251
4	Freon-12	15.0	31
	Methyl chloroform	50.0	
	PVP-VA	2.5	33
	Ethanol	30.0	
	Nitrous oxide	2.5	35
5	Freon-12	15.0	
	Methyl chloform	40.0	360
	Methylene chloride	10.0	
	PVP-VA	2.5	254
	Ethanol	30.0	
	Nitrous oxide	2.5	368

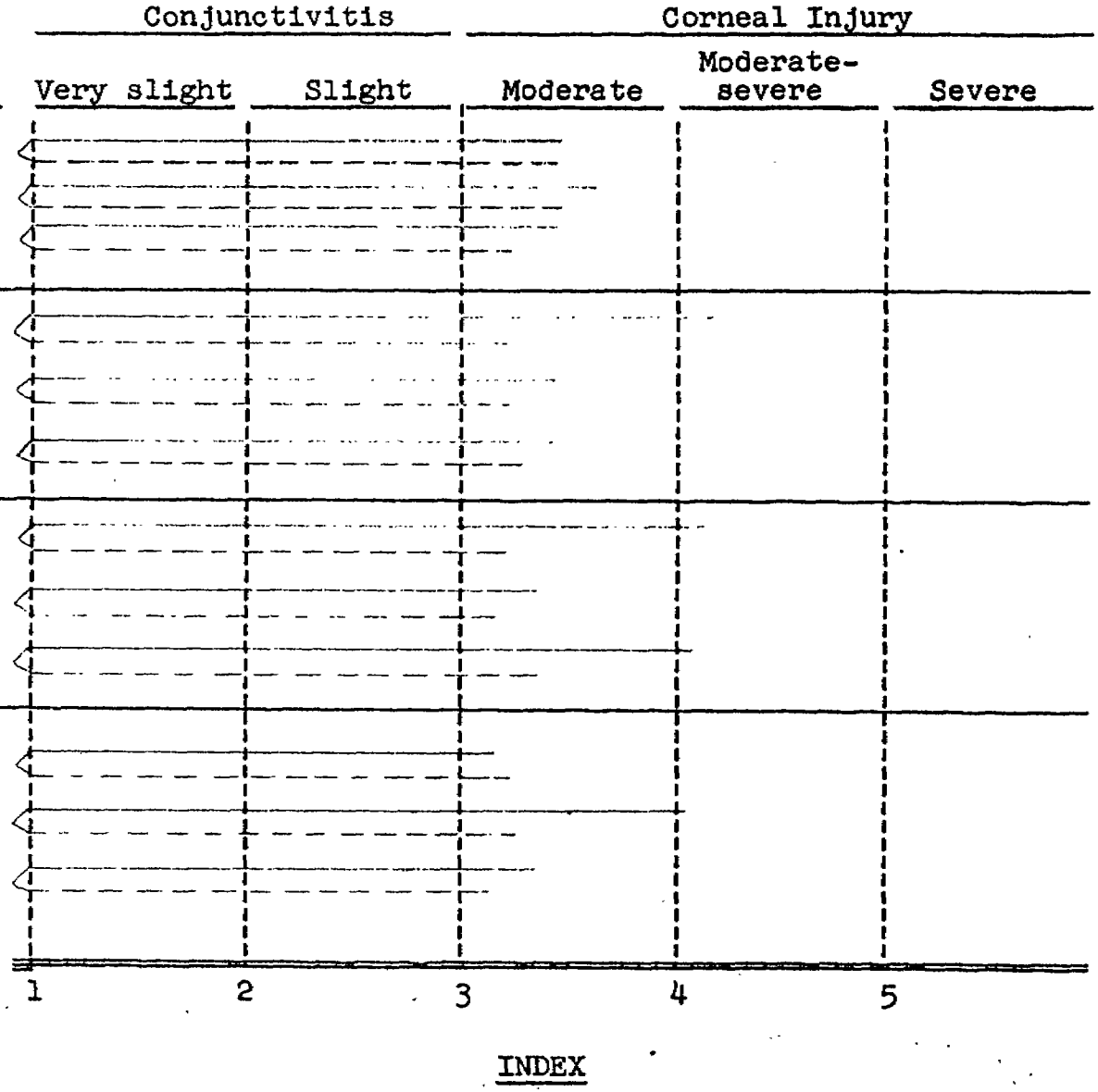


Table 3 - continued

Dow Sample Number	Hair Spray Formulation	(%)	Animal Number	Conjunctivitis: Very slight	Conjunctivitis: Slight	Corneal Injury: Moderate	Corneal Injury: Moderate-severe	Corneal Injury: Severe
6	Vinyl chloride	15.0	370					
	Methyl chloroform	50.0						
	PVP-VA	2.5	378					
	Ethanol	30.0						
	Nitrous oxide	2.5	372					
7	Vinyl chloride	15.0	369					
	Methyl chloroform	40.0						
	Methylene chloride	10.0	291					
	PVP-VA	2.5						
	Ethanol	30.0	295					
	Nitrous oxide	2.5						
8	Freon-12	15.0	297					
	Methyl chloroform	40.0						
	PVP-VA	2.5	377					
	Ethanol	40.0						
	Nitrous oxide	2.5	379					

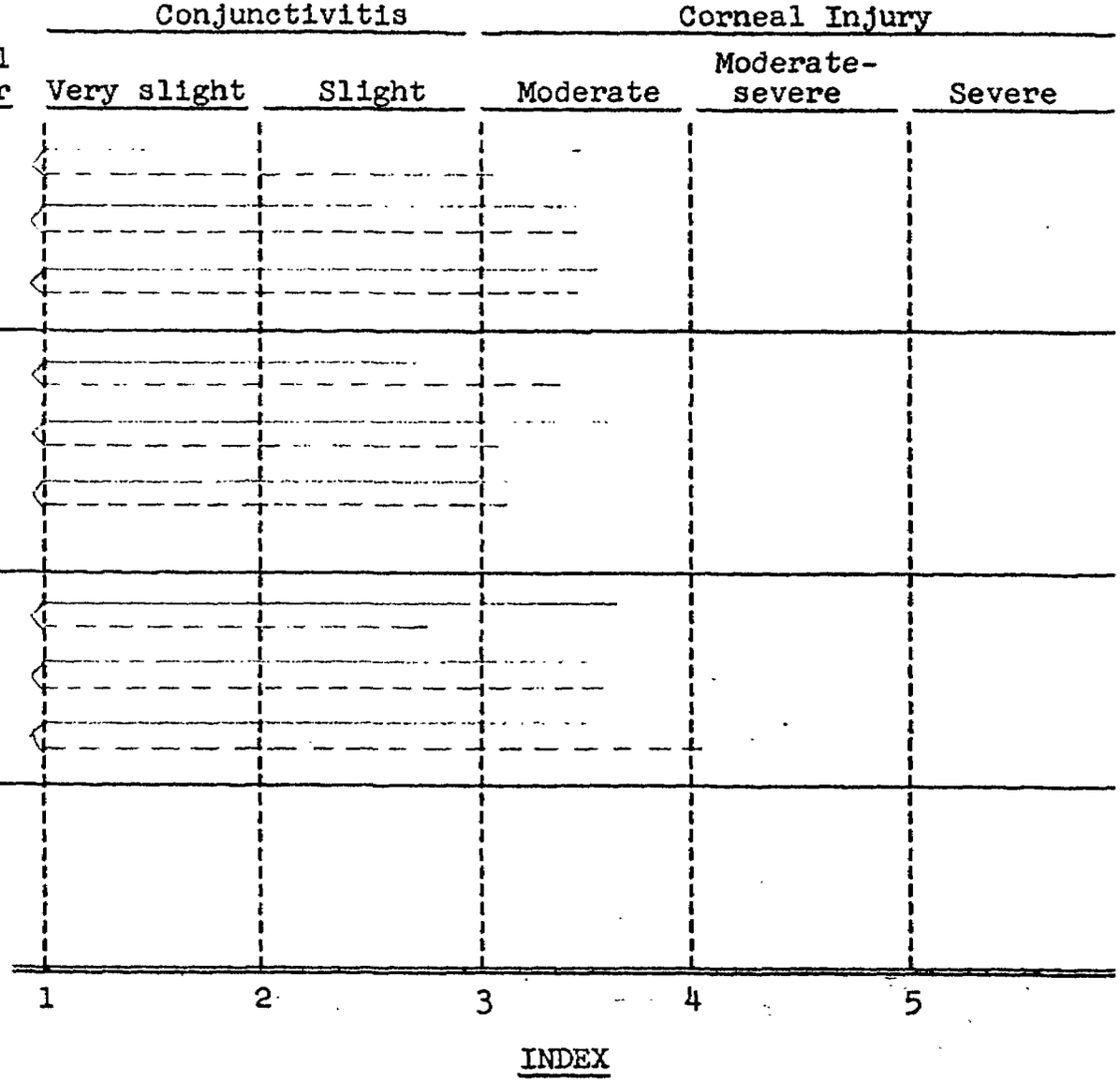
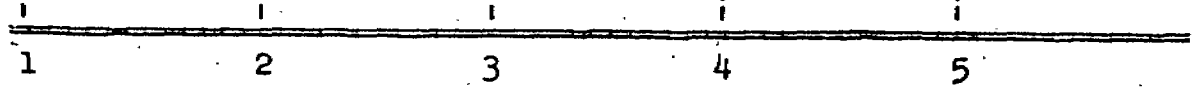


Table 3 - continued

Dow Sample Number	Hair Spray Formulation	(%)	Animal Number	Conjunctivitis: Very slight	Conjunctivitis: Slight	Corneal Injury: Moderate	Corneal Injury: Moderate-severe	Corneal Injury: Severe
9	Freon-12	15.0	385					
	Methyl chloroform	40.0						
	PVP-VA	2.5	381					
	Ethanol	40.0						
	Nitrous oxide	2.5	383					
10	Freon-12	25.0	387					
	Freon-11	15.0						
	Methylene chloride	10.0	382					
	PVP-VA	2.5						
	Ethanol	47.5	384					



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Table 4 - SKIN IRRITATION PROPERTIES OF HAIR SPRAY FORMULATIONS WHEN APPLIED TO INTACT (i) AND ABRADED (a) RABBIT SKIN

Material	Site	Index of Response After Application Number									
		1	2	3	4	5	6	7	8	9	10
Proprietary 1	Ear (i)	1	1	2	2	3	3	3	3	3	3
	Belly (i)	1	2	2	2	3	3	3	3	3	3
	Belly (a)	4	4	4	healed normally						
Proprietary 2	Ear (i)	1	3	3	3	3	3	3	3	3	3
	Belly (i)	1	2	3	3	3	3	3	3	3	3
	Belly (a)	2	3	3	healed normally						
Proprietary 3	Ear (i)	2	2	2	3	3	3	3	3	3	3
	Belly (i)	2	2	3	3	3	3	3	3	3	3
	Belly (a)	2	3	3	healed normally						
Proprietary 4	Ear (i)	1	3	3	3	3	3	3	3	3	3
	Belly (i)	3	3	3	3	3	3	3	3	3	3
	Belly (a)	4	4	4	healed normally						
Proprietary 5	Ear (i)	1	1	2	2	2	3	3	3	3	3
	Belly (i)	2	2	3	3	3	3	3	3	3	3
	Belly (a)	4	4	4	healed with slight scar						
Proprietary 6	Ear (i)	2	2	3	3	3	3	3	3	3	3
	Belly (i)	2	2	2	3	3	3	3	3	3	3
	Belly (a)	2	3	3	healed normally						
Proprietary 7	Ear (i)	2	2	3	3	3	3	3	3	3	3
	Belly (i)	1	2	3	3	3	3	3	3	3	3
	Belly (a)	3	3	3	healed normally						

continued

Table 4 - continued

Material	Site	Index of Response After Application Number 1	2	3	4	5	6	7	8	9	10
Proprietary 8	Ear (i)	2	3	3	3	3	3	3	3	3	3
	Belly (i)	3	3	3	3	3	3	3	3	3	3
	Belly (a)	4	4	4	healed with slight scar						
Proprietary 9	Ear (i)	1	2	2	2	2	2	2	2	2	2
	Belly (i)	2	2	2	3	3	3	3	3	3	3
	Belly (a)	3	3	4	healed normally						
Proprietary 10	Ear (i)	2	3	3	3	3	3	3	3	3	3
	Belly (i)	2	2	3	3	3	3	3	3	3	3
	Belly (a)	3	4	4	healed with slight scar						
Proprietary 11	Ear (i)	2	3	3	3	3	3	3	3	3	3
	Belly (i)	3	3	3	3	3	3	3	3	3	3
	Belly (a)	3	4	4	healed with slight scar						
Dow Sample 1 (Control)											
Freon-12 25.0%	Ear (i)	1	3	3	3	3	3	3	3	3	3
Freon-11 25.0%	Belly (i)	1	3	3	3	3	3	3	3	3	3
Ethanol 47.5%	Belly (a)	4	4	4	healed with slight scar						
Resin (PVP/VA) 2.5%											
Dow Sample 2											
Freon-12 25.0%	Ear (i)	1	3	3	3	3	3	3	3	3	3
Methyl chloroform 25.0%	Belly (i)	3	3	3	3	3	3	3	3	3	3
Ethanol 47.5%	Belly (a)	4	4	4	healed with slight scar						
Resin (PVP/VA) 2.5%											

continued

Table 4 - continued

Material		Site	Index of Response After Application Number 1	2	3	4	5	6	7	8	9	10
Dow Sample 3												
Freon-12	25.0%	Ear (i)	1	2	3	3	3	3	3	3	3	3
Methyl chloroform	15.0%	Belly (i)	1	1	3	3	3	3	3	3	3	3
Methylene chloride	10.0%	Belly (a)	3	4	4	healed with slight scar						
Ethanol	47.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 4												
Freon-12	15.0%	Ear (i)	2	3	3	3	3	3	3	3	3	3
Methyl chloroform	50.0%	Belly (i)	2	3	3	3	3	3	3	4	4	4
Ethanol	30.0%	Belly (a)	3	3	4	healed normally						
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 5												
Freon-12	15.0%	Ear (i)	2	3	3	3	3	3	3	3	4	4
Methyl chloroform	40.0%	Belly (i)	3	4	4	4	4	4	4	4	4	4
Methylene chloride	10.0%	Belly (a)	4	4	5	healed with scar						
Ethanol	30.0%											
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 6												
Vinyl chloride	15.0%	Ear (i)	1	3	3	3	3	3	3	3	3	3
Methyl chloroform	50.0%	Belly (i)	3	4	4	4	4	5	5	5	5	5
Ethanol	30.0%	Belly (a)	4	5	5	healed with moderate scar						
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											

continued

Table 4 - continued

Material		Site	Index of Response After Application Number 1	2	3	4	5	6	7	8	9	10
Dow Sample 7												
Vinyl chloride	15.0%	Ear (i)	2	3	3	3	3	3	3	3	3	3
Methyl chloroform	40.0%	Belly (i)	3	3	3	3	3	3	4	4	4	4
Methylene chloride	10.0%	Belly (a)	3	4	4	healed with slight scar						
Ethanol	30.0%											
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 8												
Freon-12	15.0%	Ear (i)	1	2	3	3	3	3	3	3	3	3
Methyl chloroform	40.0%	Belly (i)	2	3	3	3	3	3	3	3	4	4
Ethanol	40.0%	Belly (a)	3	4	4	healed with slight scar						
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 9												
Freon-12	15.0%	Ear (i)	1	3	3	3	3	3	3	3	3	3
Methyl chloroform	30.0%	Belly (i)	2	3	3	3	3	3	3	3	3	3
Methylene chloride	10.0%	Belly (a)	3	3	4	healed normally						
Ethanol	40.0%											
Nitrous oxide	2.5%											
Resin (PVP/VA)	2.5%											
Dow Sample 10												
Freon-12	25.0%	Ear (i)	1	2	3	3	3	3	3	3	3	3
Freon-11	15.0%	Belly (i)	2	3	3	3	3	3	3	3	3	3
Methylene chloride	10.0%	Belly (a)	3	3	4	healed normally						
Ethanol	47.5%											
Resin (PVP/VA)	2.5%											