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Bloat Results From Various Drenchings Including Effectiveness of Penicillin For Prevention

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BLOAT

RESULTS FROM VARIOUS DRENCHINGS INCLUDING EFFECTIVENESS OF PENICILLIN FOR PREVENTION

By

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EFFECTIVENESS OF PENICILLIN

FOR PREVENTION

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser

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INTRODUCTION

Bloat in ruminants is still a major problem all over the world. Despite intensive investigation, the actual cause, or causes, are still unknown. Bloat is a confusing problem and probably much more complex than is generally considered. An ancient Roman author (cited by Dougherty, 29), 60 A. D., described bloat in terms which leave no doubt that the symptoms have not changed much through the centuries. However, because of the greatly increased usage of legume pastures in recent years, bloat has become a serious problem.

Just what is bloat? It is an excessive accumulation of gases which causes a distention of the rumen. All researchers agree that the reason for an excessive accumulation of gases under certain feeding conditions is that the animal, for some unknown reason, cannot "belch". Gas is eliminated by eructation and absorption. If the animal can belch freely, the gas accumulation is prevented.

Bloat has been classified according to severity. The most widely suggested classification is "chronic, subacute and acute". Chronic bloat is due to an abnormality of the animal occurring irrespective of the nature of the ration. Subacute bloat usually depends on the nature of the ration with symptoms of a slight bulging of the left flank. Acute bloat is similar to subacute bloat except the condition is further advanced and other symptoms such as frequent urination, defecation

and labored breathing are present.

Since there is a factor or factors in alfalfa as well as other legumes which are contributing agents causing bloat, a series of experiments were devised to ascertain the following information: (a) the possibility of some bloat-producing factors being present in legumes and grasses, (b) if such factors are present, how would they affect the incidence and severity of bloat, (c) to determine if there is a relationship among sugar, protein, solids, environmental temperature and humidity towards the production of bloat, and (d) to study physiological disturbances with special reference to the heart and respiration rates.

REVIEW OF LITERATURE

Physiology and Anatomy in Relation to Bloat

Normal eructation in ruminants is necessary for the escape of ruminal gases, and therefore is of major importance. Cole et al. (23) and Quin (80) have stated that eructation is a reflex. Eructation was found to be dependent upon the reflex opening of the cardiac orifice (57). The vagus nerve, which is parasympathetic, supplies excitatory fibers to the ruminant stomach as shown by Dougherty (28). When the vagus nerve is severed, the ability to eructate is lost and rumen motility ceases (34). Clark (13) concluded that the vagi are motor nerves to the rumen and reticulum.

Wester (93) observed that eructation could occur in an animal with an open fistula and concluded that an increased intraruminal pressure is not essential to initiate the reflex. Dougherty (28) and Nichols (65) have shown that increasing intraruminal pressure by insufflation increases ruminal activity and eructation. The theory that the presence of coarse material in the rumen stimulated the eructation reflex as shown by Mead, Cole and Regan (22, 60) is not fully accepted. Nichols (66) states, "the stimulus for belching is a pressure, not scratching of the rumen wall."

Several investigators (11, 21, 23, 28, 39, 60) have associated eructation with rumen motility. Cinefluorographic

studies on eructation have shown several phenomena relating to eructation. Apparently, eructation can be accomplished when the cardia is either partially or completely submerged in ingesta (31). In addition, the esophagus does not have to open with every ruminal contraction (93) and likewise eructation can be accomplished during rumen paralysis (15, 31). In the normal animal, however, rumen motility is a vital part of rumination.

Since the physiology of eructation appears to be closely related to rumen motility, Weiss (17, 91) has divided rumen contractions into two types: "(1) A backward moving cycle of contractions, involving a two-stage contraction of the reticulum, immediately followed by a contraction of the left dorsal and right ventral sacs, followed by a pause of varying length; (2) a forward moving ruminal contraction starting at the posterior dorsal blind sac, followed by another pause of varying length." Dougherty and Meredith (31) noted that the reticulum contracted vigorously twice prior to the major rumen contraction; the last reticular contraction cleared the reticulum of most of its ingesta; the rumino-reticular fold became quite active in preventing ingesta from flowing or falling back into the emptied reticulum by rising approximately to the level of the cardia; the reticulum dilated synchronously with contraction of the caudal part of the rumen, which forced gas forward into the region around the cleared cardia and downward into the relaxed reticulum.

Microbiology of the Rumen

Highly specialized ciliate protozoa, not found in other habitats, occur in the rumen in numbers ranging between 100,000 and 3,000,000 per milliliter of content (24). Direct counts of bacteria indicate that they occur in numbers between 10 and 60 billion per milliliter of rumen contents (24). The great majority of the rumen microorganisms are small rods, cocci, and are anaerobic.

Several workers, Barcroft *et al.* (4), Elsden (37), and Carroll and Hungate (10) have found that microbial fermentation in the rumen gives rise to carbon dioxide, methane, acetic acid, propionic acid, and butyric acid. These acids are absorbed and oxidized by the host to meet an important part of its energy requirement. The carbon dioxide and methane are normally eliminated by eructation and respiration. Carbon dioxide and hydrogen being the primary products, combine to form methane and water; however, much of the carbon dioxide remains unchanged (63, 87, 94).

Hungate *et al.* (48) have found that an excess of grain or glucose introduced into the rumen causes a marked change in the rumen microorganisms. The cellulolytic bacteria are greatly decreased in numbers, the protozoa are killed, the relative number of gram positive bacteria increases, rumen motility ceases, and in many cases the animal dies (48). Hungate suggests that acetic or lactic acid added to the rumen causes cessation in rumen motility. An excess of grain

or glucose produced a high acidity in the rumen contents (pH 4.1 - 4.7). This high acidity is produced by Streptococcus bovis which multiply rapidly and synthesize lactic acid (48).

Many rumen microorganisms are rapid fermenters and gas formers. Quin places considerable importance on fermentation from an oval microorganism (24), probably a Selenomonas (59). Schizosaccharomyces ovis, a false yeast present in large numbers in the rumen of sheep, produced large volumes of gas immediately subsequent to the consumption of alfalfa (79). Delmer (26) believed the chief gas-producing microorganism in the rumen is Bacillus amylobacter, which produces carbon dioxide, hydrogen and methane. Barker (6) succeeded in isolating one species of methane-producing microorganism, namely Methanobacterium omelianskii. However, species other than Methanobacterium omelianskii may be involved in methane production in the rumen. Hungate stated that there are constant changes taking place in the microbial population of the rumen and given strains differ in major characteristics from time to time (24).

Rumen Gases

Kleiber, Cole, and Mead (55) reported the following composition for gases taken from the rumen: 67 percent CO_2; 26 percent CH_4; 7 percent N_2 + H_2; 0.1 percent H_2S; and less than 1 percent O_2. This confirms earlier analysis of gas

done by Tappeiner (24). Dougherty (27) reports the presence of carbon monoxide in concentrations up to 0.17 percent.

Olson (70) has shown the presence of both carbon monoxide and hydrogen sulfide in the rumen of normal animals, but that hydrogen sulfide is greatly increased in bloated animals. The percentage of gases, except hydrogen sulfide and methane, remain about the same in normal and bloated animals. The assumption is that hydrogen sulfide, a highly toxic gas, paralyzes the rumen wall and is subsequently absorbed into the blood stream. When a small amount of hydrogen sulfide gas enters the blood, immediate death results.

Methane in the rumen may be derived from cellulose, starch, or sugar (52). However, Mitchell *et al.* (61) observed no increase in methane production when glucose was added to the ration. Barker (5) found that the microflora outside the rumen can convert carbon dioxide to methane.

Carbon dioxide in the rumen is presumably formed from a large number of organic substances (24). Nichols (64) studied gas production both *in vitro* and *in vivo* from a variety of feedstuffs. He found *in vitro* that sugars did not increase carbon dioxide production from fermenting hay, but hays and corn produced more carbon dioxide while forages and high-protein feeds produced more hydrogen. Nichols (64) and Kleiber (55) have suggested that high-protein feeds produce a greater percentage of carbon dioxide and hydrogen than low-protein feeds. However, when Markoff (58) added sugar to rumen

content fermenting *in vitro*, the rate of carbon dioxide production was greatly increased.

According to Woods and Clifton (95) the traditional source of hydrogen from bacterial fermentations is carbohydrate, and the metabolic activity of microorganisms may result in the formation of hydrogen gas from a number of organic compounds. Sulfur-containing amino acids are likely sources of hydrogen sulfide in rumen gas (27). Olson (69) suggested bloat-producing diets produced higher levels of hydrogen sulfide than non-bloat-provoking diets. On the other hand, Kleiber *et al.* (55) found no relationship between the hydrogen sulfide concentration in rumen gas and the severity of bloat.

Swallowed air is believed to be a source of free nitrogen and oxygen often found in rumen gas. Work by Kleiber, Cole, and Mead (55) suggests that processes other than swallowing and belching might control the volumes of both nitrogen and oxygen in the rumen.

The rate of gas formation is most rapid immediately after eating. Washburn and Brody (90) found that the ratio of carbon dioxide to methane formation is not constant. They concluded that rumination does not stimulate an increase in carbon dioxide production, but that nitrogen and oxygen increase with time after eating. Jacobsen *et al.* (49) by fermentation tests *in vitro* concluded the rate of gas formation was most rapid immediately after eating and declined

rapidly during the next five hours, and then declined more slowly until 20 hours after eating. Cole and Mead (21) also reported the most rapid formation of gas occurs during or shortly after eating. Olson and Breazeale (71) found the greatest increase of hydrogen sulfide about two hours after the cows began eating.

Chemical Factors in Relation to Rumen Paralysis

Ways in which chemical factors might be involved in bloat are becoming widely recognized. Chemical factors may influence the rate of gas production in the rumen, the physical state of the ingested mass (19), and inhibit rumen motility (38). A large number of substances have been suggested because bloat primarily results from an inhibition of the eructation reflex or to the paralysis or loss of muscular tone in the rumen or reticulum.

Cyanides have been suggested as one possible factor related to bloat. Evans and Evans (39) believed that cyanide was an agent in the production of legume bloat. They concluded that juice from white clover caused a relaxation and paralysis of the rabbit intestine. Clark and Quin (16) found no inhibition of eructation when potassium cyanide was administered to sheep. Parsons et al. (75) orally administered extracts of trefoil to lambs causing death within 9 to 30 minutes with symptoms of cyanide poisoning. Weiss (92) found that potassium cyanide inhibited contractions of the rumen

and eructation in sheep. Extracts from both ladino clover and alfalfa produced excessive bloat in less than an hour, but apparently not from cyanide.

Ferguson (41, 42) isolated an active principle in alfalfa juice which inhibited the activity of isolated rabbit gut. The substance was identified as flavone tricin (44). When quercitin, a flavone which has about the same muscle inhibiting power as tricin, was fed to sheep, no bloat was produced (43). These workers concluded that flavones probably do not play a part in the production of bloat.

Alkali when injected intravenously caused ruminal paralysis, according to Clark and Lombard (14). The introduction of alkali into the rumen produced a similar effect. Hale and King (46) when studying urea toxicity found that bloat occurred when urea was administered orally in doses that were fatal or nearly fatal. They believed that the toxicity was due to the formation of ammonium carbonate.

Dougherty (28) and Clark (12) showed that the intravenous injection of histamine invoked ruminal paralysis. Dain et al. (25) identified histamine and tyramine as toxic constituents in the rumen ingesta of experimentally overfed sheep. The illness of these sheep was believed directly correlated with the level of histamine in the ingesta. Weiss (92) found that an intravenous injection of 2 mg. of histamine into a sheep completely inhibited all ruminal movements and eructation.

Several workers (17, 32, 73, 92) have used atropine to produce ruminal paralysis by blocking the parasympathetic nerve endings of the vagus nerve. Weiss (91) found that even small doses of atropine (30 mg.), insufficient for complete ruminal paralysis, resulted in complete inhibition of the eructation reflex. Atropine destroys the action of choline esterase, and when choline esterase is inhibited, acetylcholine synthesis continues and the concentration rises. An excess of acetylcholine may cause muscular spasms (51). According to Dukes (35) a nerve impulse causes the liberation of acetylcholine at the neuromuscular junction. Cholinesterase, a tissue enzyme, counteracts the action of acetylcholine thus preventing tetanus. Certain plants such as Datura species are known to contain atropine and therefore might contribute toward bloat.

Dougherty (28) showed that adrenalin causes marked depression both in strength and speed of ruminal contraction in cattle. Weiss (91) found that an intravenous injection of 1 c.c. of adrenalin hydrochloride (1:1,000) into sheep produced varying degrees of depression and even total paralysis of rumino-reticular activity. Eructation was infrequent during the period of depressed ruminal motility. Weiss concluded that it would be logical to assume that the liberation of adrenalin during excitement would tend to inhibit the eructation reflex and so contribute to the occurrence of bloat in conjunction with other factors.

Etiological Theories

The excessive gas formation theory was generally accepted until comparatively recent times. This is not supported by results which indicate that animals have the ability to eliminate far more gas through eructation than is produced in the rumen (23). Cole et al. (20, 21) and Quin (79) have done extensive work on gas formation. They have concluded there may be considerable difference in rate of gas formation from different feeds.

Jacobson et al. (49) suggest that bloat on green legumes occurs because legumes are eaten so rapidly that the feed "piles up" in such a manner that the cardiac opening is blocked; thus preventing eructation. In the opinion of many, rapid grazing, particularly during wet seasons when the forage is premature, results in many cases of bloat (40, 77). On the other hand, bloat has occurred during drought conditions.

The physical deficiency theory, advanced by Cole and associates (21), is based on the scabrous material required to mechanically stimulate eructation. However, other investigators suggest that bloat occurs even though supplemental feeding of scabrous roughage is practiced (57, 84).

Saponins have been associated with the surface tension theory. These tend to change the surface tension so that the gases of fermentation will accumulate in countless bubbles throughout the ingesta. Quin (80) has been able to produce frothy bloat by injecting saponins into the rumens of sheep.

Clark and Weiss (18) have shown that saliva may be another factor affecting surface tension. They stated the consistency of the ingesta was dependent upon salivary secretion which in turn was reflexly stimulated by the presence of coarse material in the ingesta.

Nichols' mechanical or buoyancy theory (68) is where heavy feeds like immature alfalfa or ladino clover settle to the bottom of the rumen in a compact mass. The fermentation liberates many tiny gas bubbles which are trapped and tend to hold the liquid level above the opening of the lower end of the esophagus preventing the escape of gas.

Dracy et al. (33) clamped the esophagus of sheep to prevent the escape of ruminal gas. They were determining whether or not death was due to the accumulation of gas within the rumen. The results were that the sheep bloated, but did not produce enough gas from normal fermentation of alfalfa ingesta to cause death.

In the toxic gas theory, Dougherty (29) postulates that legume plants, which most often cause bloat, contain relatively high percentages of protein which when taken into the rumen produce an excess of toxic gas. These gases in combination or singly partially paralyze the rumen thus preventing eructation. When the animal cannot eructate, the pressure is increased and the toxic gases are absorbed into the blood.

Experimental Production of Bloat

Bloat has been produced experimentally by a number of methods (22, 56, 75, 86); however, no one has been able to produce fatal bloat regularly. Furthermore, the regular production of bloat by any method is impossible in all sections of the country. The methods of producing bloat which will be discussed are: sectioning of the vagi; use of drugs; administering extracts of legumes; drenchings with saponins; feeding certain concentrate mixes with hay; and pasturing succulent alfalfa.

In 1883, Ellenberger (36) demonstrated that chronic bloat could be produced by sectioning both vagus nerves in the neck region. Weiss (91) found that when the right ventral branch was sectioned in a goat, distention and chronic bloat resulted. Sectioning the left dorsal branch diminished the strength of ruminal contractions and eructation efficiency for the first three weeks with subsequent partial recovery. Dracy and Jordan (34) did experiments on sectioning the vagus nerves on sheep that had been on legume pasture. Bloat was produced, although the animals did not die during a 24-hour period after sectioning.

The use of drugs for producing bloat has been covered previously in chemical factors in relation to rumen paralysis. Cyanide, atropine and histamine all act by inhibiting rumen motility and eructation.

Parsons et al. (75, 76) and Thomas (88) reported bloat

could be produced by drenching sheep (75) and cattle (88) that had been pastured on legumes. Parsons produced bloat with 32 ounces of alfalfa juice or ladino clover juice. Thomas stated one pint of juice will produce bloat in cattle and will kill sheep.

Lindahl et al. (56) reported that the feeding of 15 to 25 grams of saponin resulted in bloating eight out of ten sheep. Quin (80) believed that the saponin content of alfalfa caused the surface tension of the ingesta to decrease and the tendency toward foam formation to increase. Parsons (74) reported that both alfalfa saponin and cactus saponin inhibited intestinal motility.

Smith et al. (85) have produced frothy bloat in cows by feeding a ration of ground corn, soybean oil meal and two to four pounds of leafy alfalfa hay. Hungate et al. (48) produced bloat on pure ladino clover. Cole et al. (22) found that pasturing succulent, immature alfalfa eight to fourteen inches high produced bloat. They also stated that this bloat was most severe when the animals were deprived of hay for 48 hours.

Prevention and Treatment of Bloat

Cole, Mead, and Regan (22) conducted intensive studies on feeding hay before pasturing. The overnight feeding of alfalfa hay did not always prevent bloat; coarse alfalfa was more effective than fine-stemmed, leafy alfalfa. On the other hand, overnight feeding of sudan hay was completely

effective. Mead, Cole, and Regan (60) found that barley straw was not sufficient for preventing bloat when fed overnight. The pasturing on sudan overnight has proved to be effective for preventing bloat on alfalfa pasture the following day (22).

There are many other preventive procedures that are in common practice and have been used for several years. When alfalfa is cut and fed in the corrals, the incidence of bloat is reduced. Planting 50 percent of the legumes with grasses has been a common practice; however, it is difficult to maintain the proper proportion of grasses to legumes throughout the pasturing period. Another practice is to pasture legumes only after the early-bloom stage. Continuous day-and-night pasturing is frequently suggested as a means of preventing bloat. Strip grazing has been proposed as a means of controlling bloat on alfalfa pasture (2, 72). This system forces cows to eat the coarse with the succulent forage. The feeding of salt and minerals is often employed to prevent bloat.

Nichols (67) explains that detergents can prevent bloat. The detergents reduce the volume of the frothy mass and increase the specific gravity of the ruminal fluid so that roughage is more apt to stay afloat, thus allowing the water level to lower and remain below the esophageal opening.

Barrentine *et al.* (8) claimed penicillin is effective in preventing bloat. Penicillin when compared to chlortet-

racycline, oxytetracycline, bacitracin and streptomycin was found to be the only antibiotic that prevented bloat when a single dose of 300 mg. or less was given. Since penicillin is known to be effective against relatively few types of organisms, Barrentine suggested that bloat from clover may be caused by a specific type or types of microorganisms. A penicillin-salt mix has recently been prepared and is now on the market (7). This mix consists of loose salt containing 50 mg. of procaine penicillin per ounce of salt. Barrentine conducted an experiment on 19 bloat-problem farms involving 3,000 head of cattle, testing the effectiveness of this penicillin-salt mix and found only a few cases of bloat and not a single death. On the other hand, experimental trials at the Iowa station have shown no effectiveness of penicillin in preventing bloat (3).

Several measures have been suggested in the literature for the treatment of bloat. The administration of kerosene, turpentine, vinegar and mineral oil (1, 11, 12, 45, 81, 89) have been commonly used. However, Clark (11, 12) has shown that turpentine did not reduce the amount of gas formed, but that the beneficial effects of turpentine depended upon surface tension action. Quin et al. (78) have reported the use of methyl silicone to increase surface tension of the gas bubbles within the food mass. Of 155 cases of bloat in cattle, 115 made complete recoveries when treated with methyl silicone. Johns (50) used drenches of various types and found that those

containing anti-foaming agents were the only ones that were consistently successful for treating bloat. Reid (82) in New Zealand has successfully developed a method of pasture spraying for bloat control using vegetable oil sprays, particularly peanut oil. Reid and Johns (83) have found that vegetable oils are more reliable than silicones for preventing bloat.

Nichols (68) states that the administration of some of the common household detergents and surface active agents cleared the rumen of froth. Dougherty and Meredith (30) using in vitro methods have shown that several of the surface active agents are effective in the dispersal of foam and prevention of foam formation.

Kerr and Lamont (53) believe that bloat is an allergic phenomenon and report that the symptoms are relieved with three to five milliliters of adrenalin. They also state that atropine sulfate in doses of one-half grain was effective in relieving symptoms of bloat.

Moore (62) has suggested the use of antihistamines to be effective for relieving bloat. The antihistamines act in re-establishing rumen motility. Johns (50) was unable to alleviate bloat with the use of either adrenalin or antihistamines.

Mechanical treatments which are often used are the stomach tube and trocar. However, they are not effective regularly in the treatment of severely bloated animals

because of the time factor and the usual frothy condition of the ingesta.

Assessing the value of treatments is extremely difficult when it is known that many cases will recover without any treatment. Further controlled laboratory tests, preferably *in vivo* are needed. The use of anti-foaming agents and possibly penicillin have shown promise in the prevention and treatment of bloat, however, the most widely accepted control measure appears to be the use of suitable pasture management.

EXPERIMENTAL METHODS

The sheep allotted for this experiment were purchased from the Animal Husbandry Department, South Dakota State College. They were Western wethers weighing approximately 75 pounds.

General Management

All sheep were under the same management throughout this experiment. The wethers were on a dry lot when not being drenched. Following drenching, the sheep were confined to separate pens for observation.

The ration consisted of alfalfa hay (ad-lib.) and free access to salt and water. However, for one experiment the wethers were fasted four consecutive days receiving nourishment from the alfalfa drench only.

Numbers

Ten sheep were started on this experiment; however, one died (No. 44) after three drenches with alfalfa juice and another (No. 57) died after two drenches with alfalfa juice plus one drench with a one percent glucose solution. Two lambs weighing approximately 75 pounds replaced the two that died. Two other sheep (Nos. 45 and 50) died later on in the experiment, but were not replaced.

Preparation of the Drench

Alfalfa juice was prepared first by selecting a uniform

field of alfalfa to supply fresh, green material. The alfalfa was in the prebloom stage because this is considered the most dangerous stage of maturity for producing bloat. This alfalfa was from four to six inches in height. The alfalfa was cut early in the morning (7:00 - 9:00 A.M.) with either a power mower or a hand scythe. It was picked up and taken to the laboratory for extraction as quickly as possible. There it was ground with a meat grinder, and the juice was extracted from this material with a lard press.

Brome grass juice was prepared in the same manner as alfalfa juice. The height of the grass was from three to six inches. The brome grass was taken almost entirely from an irrigated field since the season was too dry to get a sufficient growth from a non-irrigated field.

The alfalfa juice concentrate was prepared to concentrate the saponins by heating the freshly extracted juice to coagulate the protein. The material was filtered to remove the coagulated protein and the filtrate was further concentrated in a vacuum flask evaporator giving a syrupy brown liquid. This was mixed with an equal volume of alcohol. Upon addition of alcohol, a light gray precipitate, apparently a pectin, was flocculated. The liquid portion was then diluted with water and evaporated to remove the alcohol. After the alcohol was completely evaporated, the remaining portion was used to test its bloat-producing properties on sheep.

The alfalfa juice concentrate treated with cholesterol

was obtained by stirring 500 grams of cholesterol into two liters of alfalfa juice concentrate. The residue was ground in a ball mill for 24 hours and centrifuged producing a sticky substance without an appreciable reduction in foaming ability.

Quantity of Juice Used

Every sample used in this experiment was calculated to equal nine percent of the sheep's body weight. Both the alfalfa juice concentrate and the alfalfa juice concentrate treated with cholesterol were diluted with water to equal nine percent of the sheep's body weight and still contain 10 percent solids and 20 percent solids respectively.

Treatment

The juice was administered to the sheep soon after processing to limit the amount of chemical changes which might take place. A stomach tube was placed into the sheep's esophagus and extended into the rumen. With a funnel in the opposite end of the stomach tube, a measured quantity of juice was given to each sheep.

One gram of glucose was added to each 100 milliliters of alfalfa juice and brome grass juice to speed up fermentation in the rumen. The control for alfalfa juice and brome grass juice consisted of an equal number of sheep receiving a one percent glucose solution.

Atropine was used in another trial to increase the

incidence and severity of bloat. Atropine, as reported by Dougherty (28), inhibits rumen motility and prevents the escape of ruminal gases by eructation. A subcutaneous injection of one grain of atropine was given to each sheep approximately 10 to 15 minutes before drenching with alfalfa juice or brome grass juice. Previous work by Dracy (32) suggests that four grains of atropine would inhibit rumen motility in mature cows; therefore, on this basis, one grain of atropine was used to insure the inhibition of rumen motility in sheep. The control for alfalfa juice and brome grass juice with the atropine treatment was the injection of one grain of atropine into sheep that later were drenched with a one percent glucose solution.

The alfalfa juice concentrate which consisted of 550 grams of solids per liter was diluted to equal 10 and 20 percent solids. The alfalfa juice concentrate treated with cholesterol was also diluted to equal 20 percent solids. A group of sheep were then treated with both 10 and 20 percent solids to determine if the incidence and degree of bloat would change. The above solution was given at the rate of nine percent of the body weight.

Penicillin was given as a drench to determine if bloat could be prevented when the sheep were drenched with alfalfa juice. Recent studies by Barrentine (8) have shown that cattle, when treated with 25 mg. of penicillin, did not bloat for three days.

The sheep selected for this experiment were those which bloated nearly 100 percent of the time. Each sheep was given 25 mg. of procaine penicillin approximately 18 hours before being drenched with alfalfa juice. Following this treatment, each sheep was drenched daily until it bloated. When the sheep bloated, they were given another dose of penicillin and again drenched daily with alfalfa juice until they bloated.

Recordings

The heart rate, respiration rate and abdominal circumference were taken on each animal before and after each drench. These sheep were handled with as much ease as possible when taking these recordings. The recordings were made after the drench as soon as the sheep seemed to be quiet, which took approximately 15 minutes. In most cases, the heart rate, respiration rate and abdominal circumference were taken at hourly intervals for three hours after each drench. The sheep were also closely observed from the time they were drenched until they appeared normal.

The heart rate was taken by counting the beats per minute with the aid of a stethoscope. The stethoscope was also used in taking the respiration rate by holding it over the trachea and recording the inhalations per minute. The abdominal circumference was measured by placing a tape measure around the greatest expansion of the abdomen.

The temperature and humidity were taken each day the sheep were drenched by placing the thermometer and the humidity gauge in the pen with the sheep.

The percent solids of the processed juice was determined for each day the sheep were drenched. This was done by taking 100 milliliters of juice and drying it in an oven at 95 degrees Centigrade. One hundred milliliters of the juice was also frozen for future analysis.

Analyses for reducing and non-reducing sugars, total protein and non-heat precipitated protein were taken from occasional samples to determine if a relationship existed among the different values and the incidence of bloat. The sugar analysis was determined by the Hassid method (47). The samples were prepared for this analysis by the following procedure: 20 milliliters of juice were diluted with alcohol plus water to give a final alcohol concentration of 80 percent. The solution was mixed and allowed to stand overnight. The volume of the solution was 250 milliliters. Samples of this solution were than taken for analysis by pipetting off from the clear supernatant part of the sample extract. The protein analysis was determined by using the Kjeldahl method (54). Protein was calculated by multiplying 6.25 times the quantity of nitrogen obtained.

RESULTS

The results of this experiment are divided into twelve sections. The first ten sections are devoted to the types of drenches given the sheep; the last two are temperature, humidity and chemical analyses, and summary of heart rate, respiration rate and abdominal circumference.

Alfalfa Juice

Ten sheep were drenched with alfalfa juice a total of 44 times. Slight bloat was produced in 31.8 percent of the cases. The individual results (Table 1) indicate that the animal either suffered from slight bloat or showed no unusual effects. The abnormal effects observed after the animal had been drenched were dyspnea and signs of discomfort in several cases. These symptoms diminished quite rapidly except in a few cases where dyspnea prolonged for two or three hours. The animals that displayed no abnormal symptoms began eating much sooner than animals suffering from slight bloat.

Two sheep died during this experiment. A post-mortem examination of sheep no. 44 revealed that the alfalfa juice had entered the lungs, producing instantaneous death. Sheep no. 50 showed signs of distress one hour after drenching when dyspnea set in. Its breathing became heavier and shorter, and died between 12-20 hours after drenching. No further evidence as to the cause of death was obtained from post-mortem examination. The abdominal circumference as depicted in Table 2

Table 1. Results from Drenching Sheep with Alfalfa Juice

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
6-12-56	44	77	Alfalfa Juice	3080	Slight bloat; labored breathing
6-12-56	45	55	Alfalfa Juice	2200	Slight bloat
6-12-56	46	70	Alfalfa Juice	2800	No unusual effects
6-12-56	47	63	Alfalfa Juice	2520	No unusual effects
6-12-56	48	71	Alfalfa Juice	2840	Slight bloat
6-14-56	44	77	Alfalfa Juice	3080	No unusual effects
6-14-56	45	55	Alfalfa Juice	2200	No unusual effects
6-14-56	46	70	Alfalfa Juice	2800	No unusual effects
6-14-56	47	63	Alfalfa Juice	2520	No unusual effects
6-14-56	48	71	Alfalfa Juice	2840	No unusual effects
6-26-56	44*	84	Alfalfa Juice	3360	Died; juice went into lungs
6-26-56	45*	65	Alfalfa Juice	2600	No unusual effects
6-26-56	46*	79	Alfalfa Juice	3160	No unusual effects
6-26-56	47*	74	Alfalfa Juice	2960	No unusual effects
6-26-56	48*	78	Alfalfa Juice	3120	No unusual effects
6-27-56	49**	82	Alfalfa Juice	3280	No unusual effects
6-27-56	50**	83	Alfalfa Juice	3320	No unusual effects
6-27-56	51**	74	Alfalfa Juice	2960	No unusual effects
6-27-56	53**	72	Alfalfa Juice	2880	No unusual effects
6-28-56	49***	82	Alfalfa Juice	3280	No unusual effects
6-28-56	50***	83	Alfalfa Juice	3320	Labored breathing; died

*Sheep were fasted for one day except for nourishment received from the drench.
**Sheep were fasted for two days except for nourishment received from the drench.
***Sheep were fasted for three days except for nourishment received from the drench.

Table 1. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Treatment Amount ml.	Remarks
6-28-56	51***	74	Alfalfa Juice	2960	No unusual effects
6-28-56	53***	72	Alfalfa Juice	2880	Slight bloat
6-29-56	48****	78	Alfalfa Juice	3120	No unusual effects
6-29-56	49****	82	Alfalfa Juice	3280	No unusual effects
6-29-56	51****	74	Alfalfa Juice	2960	No unusual effects
6-29-56	53****	72	Alfalfa Juice	2880	No unusual effects
7-10-56	45	71	Alfalfa Juice	2840	Slight bloat
7-10-56	46	84	Alfalfa Juice	3360	Slight bloat
7-10-56	47	66	Alfalfa Juice	2640	Labored breathing
7-10-56	48	80	Alfalfa Juice	3200	Slight bloat
7-11-56	45	71	Alfalfa Juice	2840	Slight bloat
7-11-56	46	84	Alfalfa Juice	3360	Slight bloat
7-11-56	47	66	Alfalfa Juice	2640	No unusual effects
7-11-56	48	80	Alfalfa Juice	3200	Slight bloat
7-12-56	48	80	Alfalfa Juice	3200	Slight bloat
7-12-56	49	86	Alfalfa Juice	3440	No unusual effects
7-12-56	51	73	Alfalfa Juice	2920	No unusual effects
7-12-56	53	70	Alfalfa Juice	2800	No unusual effects
7-13-56	46	84	Alfalfa Juice	3360	Slight bloat
7-13-56	49	86	Alfalfa Juice	3440	Slight bloat
7-13-56	51	73	Alfalfa Juice	2920	No unusual effects
7-13-56	53	70	Alfalfa Juice	2800	Slight bloat
8-23-56	48	81	Alfalfa Juice	3240	No unusual effects

****Sheep were fasted for four days except for nourishment received from the drench.

Table 2. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice was Administered

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
6-12-56	44	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	45	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	46	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	47	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	48	--	--	--	--	--	--	--	--	--	--	--	--
6-14-56	44	--	--	36.0	--	--	--	--	--	39.5	--	--	39.0
6-14-56	45	--	--	32.0	--	--	32.0	--	--	32.5	--	--	--
6-14-56	46	--	--	34.0	--	--	--	--	--	37.0	--	--	37.0
6-14-56	47	--	--	32.0	--	--	--	--	--	34.5	--	--	34.5
6-14-56	48	--	--	34.5	--	--	36.0	--	--	--	--	--	36.0
6-26-56	44	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	45	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	46	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	47	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	48	--	--	--	--	--	--	--	--	--	--	--	--
6-27-56	49	--	--	35.0	--	--	--	--	--	37.5	--	--	--
6-27-56	50	--	--	34.5	--	--	37.5	--	--	--	--	--	--
6-27-56	51	--	--	34.5	--	--	37.0	--	--	--	--	--	--
6-27-56	53	--	--	34.0	--	--	38.0	--	--	--	--	--	--
6-28-56	49	--	--	34.0	--	--	--	--	--	38.0	--	--	--
6-28-56	50	--	--	36.0	--	--	--	--	--	41.5	--	--	43.0

HR - Heart Rate
RR - Respiration Rate
AC - Abdominal Circumference (in inches)

Table 2. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
6-28-56	51	--	--	32.5	--	--	--	--	--	37.5	--	--	--
6-28-56	53	--	--	35.0	--	--	40.0	--	--	41.0	--	--	--
6-29-56	48	--	--	36.0	--	--	39.0	--	--	--	--	--	39.5
6-29-56	49	--	--	34.0	--	--	--	--	--	39.5	--	--	--
6-29-56	51	--	--	34.0	--	--	--	--	--	38.5	--	--	--
6-29-56	53	--	--	35.0	--	--	--	--	--	39.5	--	--	40.0
7-10-56	45	--	--	34.5	--	--	--	--	--	39.0	--	--	39.5
7-10-56	46	--	--	36.0	--	--	43.0	--	--	41.0	--	--	41.0
7-10-56	47	--	--	31.5	--	--	38.0	--	--	38.0	--	--	36.5
7-10-56	48	--	--	38.0	--	--	41.0	--	--	42.0	--	--	--
7-11-56	45	--	--	36.0	--	--	--	--	--	42.0	--	--	42.0
7-11-56	46	--	--	35.5	--	--	41.0	--	--	--	--	--	42.0
7-11-56	47	--	--	33.0	--	--	36.5	--	--	--	--	--	35.5
7-11-56	48	--	--	39.0	--	--	42.5	--	--	43.5	--	--	42.0
7-12-56	48	--	--	40.0	--	--	43.0	--	--	43.5	--	--	42.0
7-12-56	49	--	--	37.0	--	--	40.5	--	--	41.5	--	--	40.0
7-12-56	51	--	--	33.5	--	--	38.0	--	--	37.0	--	--	36.0
7-12-56	53	--	--	33.5	--	--	38.0	--	--	38.5	--	--	37.5
7-13-56	46	--	--	34.5	--	--	--	--	--	40.5	--	--	41.5
7-13-56	49	--	--	38.5	--	--	44.5	--	--	44.5	--	--	43.5
7-13-56	51	--	--	35.5	--	--	39.5	--	--	39.5	--	--	39.5
7-13-56	53	--	--	36.5	--	--	40.0	--	--	--	--	--	40.5
8-23-56	48	72	90	40.5	--	--	--	102	132	43.5	--	--	--

Table 3. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Alfalfa Juice

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
44	--	--	36.0	--	--	--	--	--	39.5	--	--	--
45	--	--	34.1	--	--	--	--	--	37.8	--	--	40.7
46	--	--	35.0	--	--	42.0	--	--	39.5	--	--	40.4
47	--	--	32.2	--	--	37.3	--	--	36.3	--	--	35.5
48	--	--	38.0	--	--	40.3	--	--	43.2	--	--	40.6
49	--	--	35.7	--	--	42.5	--	--	40.2	--	--	41.7
50	--	--	35.3	--	--	37.5	--	--	42.5	--	--	43.0
51	--	--	34.0	--	--	38.2	--	--	38.1	--	--	38.0
53	--	--	34.8	--	--	39.0	--	--	39.7	--	--	39.3
AVERAGE			35.0			39.5			39.6			39.9
CHANGE						+4.5			+4.6			+4.9

shows that sheep no. 50 expanded seven inches. This animal did not show any other signs or symptoms of bloat. The severity of bloat varied with each animal, and some animals did not bloat. When the sheep were drenched four consecutive days and received only nourishment from the drench, there were less cases of bloat than when the sheep were fed alfalfa hay. The average abdominal expansion was 4.5 inches the first hour after the drench, and continued to increase to 4.9 inches approximately two and one-half hours after the drench (Table 3).

Atropine and Alfalfa Juice

Fourty-two drenchings of alfalfa juice on eight sheep, after a subcutaneous injection of one grain of atropine, produced bloat in 59.5 percent of the cases. Again the frequency of bloat varied greatly with each animal (Table 4). Sheep no. 47 bloated seven out of seven drenchings; sheep no. 48 bloated six out of six; sheep no. 49 bloated six out of seven; and sheep no. 53 bloated five out of seven drenchings. On the other hand, sheep no. 51 did not show symptoms of bloat when drenched with juice equal to 15 percent of his body weight.

Table 5 depicts a wide variation in heart rates and respiration rates. The average heart rate as shown on Table 6 increased from 88.2 to 131.7 beats per minute within the first hour after drenching. The heart rate gradually decreased after one hour. The average respiration rate (Table 6) decreased from 74.3 to 58.3 inhalations per minute within two

Table 4. Results from Drenching Sheep with Alfalfa Juice after a Subcutaneous Injection of One Grain of Atropine

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
7-24-56	46	72	Atropine & Alf. Juice	2880	No unusual effects
7-24-56	47	66	Atropine & Alf. Juice	2640	Slight bloat
7-24-56	48	84	Atropine & Alf. Juice	3360	Slight bloat
7-25-56	49	84	Atropine & Alf. Juice	3360	Slight bloat
7-25-56	51	76	Atropine & Alf. Juice	3040	No unusual effects
7-25-56	53	70	Atropine & Alf. Juice	2800	Slight bloat
7-27-56	46	72	Atropine & Alf. Juice	2880	No unusual effects
7-27-56	47	66	Atropine & Alf. Juice	2640	Slight bloat; labored breathing
7-27-56	48	84	Atropine & Alf. Juice	3360	Slight bloat
7-31-56	49	89	Atropine & Alf. Juice	3560	Slight bloat
7-31-56	51	80	Atropine & Alf. Juice	3200	No unusual effects
7-31-56	53	75	Atropine & Alf. Juice	3000	No unusual effects
8-13-56	49	80	Atropine & Alf. Juice	3200	No unusual effects
8-13-56	51	82	Atropine & Alf. Juice	3280	No unusual effects
8-13-56	53	68	Atropine & Alf. Juice	2720	No unusual effects
8-14-56	42	64	Atropine & Alf. Juice	2560	No unusual effects
8-14-56	43	70	Atropine & Alf. Juice	2800	Slight bloat
8-14-56	46	64	Atropine & Alf. Juice	2560	No unusual effects
8-14-56	47	66	Atropine & Alf. Juice	2640	Slight bloat
8-14-56	48	80	Atropine & Alf. Juice	3200	Slight bloat

Table 4. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Treatment Amount ml.	Remarks
8-15-56	47	66	Atropine & Alf. Juice	2640	Slight bloat
8-15-56	48	80	Atropine & Alf. Juice	3200	Slight bloat
8-15-56	49	80	Atropine & Alf. Juice	3200	Slight bloat
8-15-56	51	82	Atropine & Alf. Juice	3280	No unusual effects
8-15-56	53	68	Atropine & Alf. Juice	2720	Slight bloat
8-17-56	46	64	Atropine & Alf. Juice	2560	No unusual effects
8-17-56	47	66	Atropine & Alf. Juice	2640	Slight bloat
8-17-56	48	80	Atropine & Alf. Juice	3200	Slight bloat
8-17-56	49	80	Atropine & Alf. Juice	3200	Slight bloat
8-17-56	51	82	Atropine & Alf. Juice	3280	No unusual effects
8-17-56	53	68	Atropine & Alf. Juice	2720	Slight bloat
8-22-56	47	68	Atropine & Alf. Juice	2720	Slight bloat
8-22-56	48	81	Atropine & Alf. Juice	3240	Slight bloat
8-22-56	49	81	Atropine & Alf. Juice	3240	Slight bloat
8-22-56	51	75	Atropine & Alf. Juice	3000	No unusual effects
8-22-56	53	73	Atropine & Alf. Juice	2920	Slight bloat
8-23-56	42	62	Atropine & Alf. Juice	2480	No unusual effects
8-23-56	43	70	Atropine & Alf. Juice	2800	No unusual effects
8-23-56	47	68	Atropine & Alf. Juice	2720	Slight bloat
8-23-56	49	81	Atropine & Alf. Juice	3240	Slight bloat
8-23-56	51	75	Atropine & Alf. Juice	4950*	No unusual effects
8-23-56	53	73	Atropine & Alf. Juice	2920	Slight bloat

*Received enough alfalfa juice to equal 15 percent of the sheep's body weight.

Table 5. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice and Atropine were Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
7-24-56	46	114	54	33.5	78	108	37.5	--	--	37.5	--	--	37.0
7-24-56	47	84	96	37.0	90	84	41.0	138	78	41.5	108	60	41.5
7-24-56	48	72	54	34.0	120	42	41.5	120	48	42.0	--	--	44.0
7-25-56	49	78	60	39.0	--	--	--	102	54	45.5	108	54	44.0
7-25-56	51	96	54	38.0	138	48	41.0	--	--	--	132	42	41.0
7-25-56	53	102	120	40.0	114	60	42.0	--	--	--	126	66	43.0
7-27-56	46	132	36	34.0	144	48	38.0	120	36	37.5	--	--	37.5
7-27-56	47	90	144	37.0	156	66	42.0	108	54	42.5	--	--	42.5
7-27-56	48	78	42	37.0	144	42	42.0	114	30	43.0	--	--	--
7-31-56	49	144	48	41.5	72	42	44.0	--	--	--	108	36	44.0
7-31-56	51	150	36	40.0	156	36	42.0	--	--	--	96	36	43.0
7-31-56	53	132	72	38.0	144	48	42.0	108	48	43.0	138	36	42.5
8-13-56	49	60	36	35.5	138	30	42.5	--	--	--	78	24	43.0
8-13-56	51	96	54	37.5	126	42	41.5	--	--	--	96	36	41.5
8-13-56	53	54	42	38.0	126	36	41.5	--	--	--	84	36	41.5
8-14-56	42	90	90	38.5	162	84	41.5	144	42	41.0	--	--	--
8-14-56	43	78	78	40.0	168	78	45.5	156	60	44.0	--	--	--
8-14-56	46	114	96	34.0	156	42	37.0	144	48	36.0	--	--	--
8-14-56	47	156	162	39.0	132	156	44.0	102	120	44.5	--	--	44.5
8-14-56	48	84	126	41.0	144	84	47.0	132	120	47.0	--	--	47.0

Table 5. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
8-15-56	47	60	156	36.0	90	144	45.0	72	174	42.0	--	--	--
8-15-56	48	84	120	41.0	102	72	46.5	--	--	--	90	102	45.0
8-15-56	49	84	120	42.0	108	54	48.0	--	--	--	102	102	48.0
8-15-56	51	84	36	38.5	--	--	--	132	42	42.0	90	42	42.0
8-15-56	53	72	108	38.5	108	84	45.0	--	--	--	--	--	--
8-17-56	46	146	66	34.5	168	72	36.0	--	--	--	180	72	36.0
8-17-56	47	72	192	37.0	120	96	41.5	90	168	45.0	--	--	--
8-17-56	48	84	168	40.0	156	78	46.0	--	--	--	138	66	45.0
8-17-56	49	84	84	41.0	90	66	46.5	--	--	--	102	60	47.0
8-17-56	51	84	48	37.0	--	--	--	120	48	41.5	96	42	41.0
8-17-56	53	84	48	39.0	120	78	45.0	--	--	--	96	48	42.5
8-22-56	47	78	162	38.5	--	--	--	114	126	46.0	--	--	--
8-22-56	48	78	54	40.0	--	--	--	132	54	45.5	--	--	--
8-22-56	49	72	30	40.0	138	60	47.0	--	--	--	--	--	--
8-22-56	51	84	30	40.5	150	72	43.0	--	--	--	--	--	--
8-22-56	53	66	54	38.0	144	90	47.0	--	--	--	--	--	--
8-23-56	42	--	--	40.0	--	72	--	--	--	--	--	--	--
8-23-56	43	60	48	38.5	--	--	--	78	42	42.5	--	--	--
8-23-56	47	60	90	36.0	--	--	--	108	120	42.0	--	--	--
8-23-56	49	60	30	38.0	--	--	--	126	42	43.5	--	--	--
8-23-56	51	84	42	38.0	--	--	--	126	42	42.0	--	--	--
8-23-56	53	84	60	39.0	--	--	--	--	--	--	120	--	39.0

Table 6. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Atropine and Alfalfa Juice

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
42	90	90	38.5	162	84	41.5	144	42	41.0	--	--	--
43	69	63	39.3	168	78	45.5	117	51	43.3	--	--	--
45	78	42	34.0	90	42	32.5	102	60	32.5	--	--	--
46	126.5	63	34.0	136.5	67.5	37.1	132	42	37.0	180	72	36.8
47	85.7	143.1	37.2	117.6	109.2	42.7	104.6	127.1	43.8	108	60	42.8
48	80	94	38.8	133.2	63.6	44.6	124.5	63	44.4	109	84	45.3
49	83.1	58.3	39.6	109.2	50.4	45.6	114	48	44.5	99.6	55.2	45.2
51	96.9	42.9	38.5	142.5	49.5	41.9	126	44	41.8	102	49.5	41.7
53	84.9	72	39.6	126	66	43.8	108	48	43.0	112.8	46.5	41.7
AVERAGE	88.2	74.3	37.7	131.7	67.8	41.7	119.1	58.3	41.3	118.6	61.2	42.3
CHANGE				↗43.5	-6.5	↗4.0	↗30.9	-16.0	↗3.6	↗30.4	-13.1	↗4.6

hours after the drenching and then began to increase. The average abdominal circumference (Table 6) showed its greatest increase of 5.6 inches approximately two and one-half hours after the drenching.

Brome Grass Juice

Seven sheep received a total of 30 drenchings with brome grass juice. None of these sheep bloated (Table 7). After drenching, a few sheep did show the same symptoms of dyspnea and uneasiness as observed following the alfalfa juice drenchings and atropine plus alfalfa juice drenchings.

The heart rate and respiration rate (Table 8) varied considerably. The heart rate increased from 76.6 to 109.2 beats per minute and then decreased (Table 9). The respiration rate decreased the first hour after the drenching, but increased 16 inhalations per minute the next hour; however, the rate returned to normal the following hour (Table 9).

The brome grass for this drench was taken from the same irrigated field each day except for July 17. On this date, it was taken from a roadside ditch that was non-irrigated. In either case, the results were the same.

Atropine and Brome Grass Juice

Following a subcutaneous injection of one grain of atropine, nine sheep were drenched a total of 30 times. None of the sheep bloated (Table 10). The sheep exhibited

Table 7. Results from Drenching with Brome Grass Juice

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
7-17-56	45	69	Brome Grass*	2760	No unusual effects
7-17-56	46	83	Brome Grass*	3320	No unusual effects
7-17-56	48	82	Brome Grass*	3280	No unusual effects
8-1-56	46	75	Brome Grass	3000	No unusual effects
8-1-56	47	70	Brome Grass	2800	No unusual effects
8-1-56	48	86	Brome Grass	3440	No unusual effects
8-1-56	49	89	Brome Grass	3560	No unusual effects
8-1-56	51	80	Brome Grass	3200	No unusual effects
8-1-56	53	75	Brome Grass	3000	No unusual effects
8-2-56	48	86	Brome Grass	3440	No unusual effects
8-2-56	49	89	Brome Grass	3560	No unusual effects
8-2-56	51	80	Brome Grass	3200	No unusual effects
8-2-56	53	75	Brome Grass	3000	No unusual effects
8-6-56	46	71	Brome Grass	2840	No unusual effects
8-6-56	47	63	Brome Grass	2530	No unusual effects
8-6-56	48	76	Brome Grass	3040	No unusual effects
8-6-56	49	78	Brome Grass	3120	No unusual effects
8-6-56	51	79	Brome Grass	3160	No unusual effects
8-6-56	53	68	Brome Grass	2720	No unusual effects
8-8-56	47	63	Brome Grass	2520	No unusual effects
8-8-56	48	76	Brome Grass	3040	No unusual effects
8-8-56	49	78	Brome Grass	3120	No unusual effects

*Was taken from a non-irrigated field.

Table 7. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Treatment Amount ml.	Remarks
8-8-56	51	79	Brome Grass	3160	No unusual effects
8-8-56	53	68	Brome Grass	2720	No unusual effects
8-9-56	46	71	Brome Grass	2840	No unusual effects
8-9-56	47	63	Brome Grass	2520	No unusual effects
8-9-56	48	76	Brome Grass	3040	No unusual effects
8-9-56	49	78	Brome Grass	3120	No unusual effects
8-9-56	51	79	Brome Grass	3160	No unusual effects
8-9-56	53	68	Brome Grass	2720	No unusual effects

Table 8. Heart Rate, Respiration Rate and Abdominal Circumference when Brome Grass Juice was Administered

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
7-17-56	45	76	79	34.0	87	52	36.5	--	--	36.0	--	--	--
7-17-56	46	110	76	38.0	138	72	41.5	--	--	42.0	--	--	--
7-17-56	48	73	62	36.0	74	60	42.5	--	--	41.5	--	--	--
8-1-56	46	108	48	35.0	--	--	--	150	54	38.0	150	54	38.0
8-1-56	47	60	36	35.5	--	--	--	96	36	38.0	84	54	37.5
8-1-56	48	72	30	35.5	--	--	--	84	30	37.5	84	36	37.5
8-1-56	49	120	42	40.0	--	--	--	--	--	--	102	48	42.0
8-1-56	51	120	42	37.0	--	--	--	--	--	--	150	36	39.0
8-1-56	53	90	78	38.0	--	--	--	--	--	--	132	30	37.5
8-2-56	48	72	30	37.0	102	30	38.0	--	--	--	96	42	37.0
8-2-56	49	72	36	39.0	114	24	40.0	--	--	--	102	24	40.0
8-2-56	51	90	30	38.0	144	30	38.5	--	--	--	120	30	38.0
8-2-56	53	84	42	36.5	102	42	38.5	114	42	38.5	--	--	--
8-6-56	46	144	84	34.0	--	--	--	180	96	36.0	132	96	36.0
8-6-56	47	72	72	33.0	84	96	34.5	--	--	--	78	90	34.0
8-6-56	48	72	36	36.5	66	24	35.5	84	90	37.0	--	--	--
8-6-56	49	84	30	34.5	72	24	36.0	--	--	--	72	36	37.0
8-6-56	51	108	42	37.0	120	30	38.5	126	42	37.0	--	--	--
8-6-56	53	84	60	33.0	174	36	36.0	90	72	33.0	--	--	--
8-8-56	47	72	48	35.5	132	60	37.5	--	192	38.0	--	--	--
8-8-56	48	60	42	37.5	102	30	39.5	84	96	38.5	--	--	--

Table 8. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
8-8-56	49	60	36	37.5	66	24	38.0	84	60	38.5	--	--	--
8-8-56	51	114	36	36.5	126	36	36.5	120	36	37.0	--	--	--
8-8-56	53	84	108	37.0	90	60	38.5	102	120	37.5	--	--	--
8-9-56	46	132	90	34.5	144	66	37.0	144	72	36.0	150	84	36.0
8-9-56	47	60	72	35.5	84	144	39.0	102	144	39.5	84	60	37.5
8-9-56	48	66	36	38.0	84	42	40.0	96	42	41.5	78	84	40.0
8-9-56	49	72	30	39.0	72	36	40.0	84	30	40.0	84	54	39.5
8-9-56	51	102	30	38.0	138	42	41.0	120	42	39.5	114	48	40.5
8-9-56	53	66	66	38.0	96	54	40.5	114	60	41.0	84	78	39.5

Table 9. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Brome Grass Juice

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
45	76	79	34.0	87	52	36.5	--	--	36.0	--	--	--
46	123.5	74.5	35.4	141	79	39.2	158	74	38.0	144	78	36.7
47	66	57	34.9	100	100	37.0	99	124	38.5	82	68	36.3
48	69.2	39.3	36.8	85.6	37.2	39.1	87	64.5	39.2	86	54	38.2
49	81.6	34.8	38.0	81	27	38.5	84	45	39.3	90	40.5	39.6
51	106.8	36	37.3	132	34.5	38.6	122	40	37.8	128	38	39.2
53	81.6	70.8	36.5	115.5	48	38.4	105	73.5	37.5	108	54	38.5
AVERAGE	76.6	55.9	36.1	106	54.0	38.2	109.2	70.2	38.0	106.3	55.4	38.1
CHANGE				⁄29.4	-1.9	⁄2.1	⁄32.6	⁄14.3	⁄1.9	⁄29.7	-.5	⁄2.0

the same physical effects as from the brome grass drench. Table 11 shows that the heart rate, respiration rate and abdominal circumference were quite similar to the results from drenching with brome grass juice. The average heart rate had its greatest increase the first hour after drenching, and then gradually decreased (Table 12). The average respiration rate decreased the first hour after the drenching and then increased. The abdomen expanded an average of 3.7 inches during these experiments.

Control - One Percent Glucose Solution

A one percent glucose drench was administered to the control group of sheep similar to the alfalfa juice and brome grass juice drenchings. Nine sheep were drenched a total of 42 times; there was no sign of bloat (Table 13). The usual physical effects noticed were similar when compared to the other drenchings. Sheep no. 52 died during this experiment because too much liquid entered the lungs during drenching. Sheep no. 45 appeared to have acute indigestion on July 13th. This sheep was discontinued from the experiment for several days until the symptoms of indigestion disappeared.

When the sheep were drenched four consecutive days and received their only nourishment from the drench, there were no cases of bloat. The abdominal expansion for each sheep is given in Table 14. Table 15 shows the abdomen increased an average of 3.2 inches the first hour after

Table 10. Results from Drenching Sheep with Brome Grass Juice after a Subcutaneous Injection of One Grain of Atropine

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
8-1-56	45	62	Atropine & Brome Grass	2450	No unusual effects
8-7-56	46	71	Atropine & Brome Grass	2840	No unusual effects
8-7-56	47	63	Atropine & Brome Grass	2520	No unusual effects
8-7-56	48	76	Atropine & Brome Grass	3040	No unusual effects
8-7-56	49	78	Atropine & Brome Grass	3120	No unusual effects
8-16-56	42	64	Atropine & Brome Grass	2560	No unusual effects
8-16-56	43	70	Atropine & Brome Grass	2800	No unusual effects
8-16-56	46	64	Atropine & Brome Grass	2560	No unusual effects
8-16-56	47	66	Atropine & Brome Grass	2640	No unusual effects
8-16-56	48	80	Atropine & Brome Grass	3200	No unusual effects
8-16-56	49	80	Atropine & Brome Grass	3200	No unusual effects
8-16-56	51	82	Atropine & Brome Grass	3280	No unusual effects
8-16-56	53	68	Atropine & Brome Grass	2720	No unusual effects
8-20-56	42	62	Atropine & Brome Grass	2480	No unusual effects
8-20-56	43	70	Atropine & Brome Grass	2800	No unusual effects
8-20-56	46	68	Atropine & Brome Grass	2720	No unusual effects
8-20-56	47	68	Atropine & Brome Grass	2720	No unusual effects
8-21-56	49	81	Atropine & Brome Grass	3240	No unusual effects
8-21-56	51	75	Atropine & Brome Grass	3000	No unusual effects
8-21-56	53	73	Atropine & Brome Grass	2920	No unusual effects
8-24-56	43	70	Atropine & Brome Grass	2800	No unusual effects
8-24-56	47	68	Atropine & Brome Grass	2720	No unusual effects

Table 10. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Amount ml.	Remarks
8-24-56	48	81	Atropine & Brome Grass	3240	No unusual effects
8-24-56	49	81	Atropine & Brome Grass	3240	No unusual effects
8-24-56	51	75	Atropine & Brome Grass	3000	No unusual effects
8-24-56	53	73	Atropine & Brome Grass	2920	No unusual effects
8-25-56	43	70	Atropine & Brome Grass	2800	No unusual effects
8-25-56	47	68	Atropine & Brome Grass	2720	No unusual effects
8-25-56	48	81	Atropine & Brome Grass	3240	No unusual effects
8-25-56	49	81	Atropine & Brome Grass	3240	No unusual effects

Table 11. Heart Rate, Respiration Rate and Abdominal Circumference when Brome Grass Juice and Atropine were Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
8-1-56	45	102	48	32.5	--	--	--	126	54	33.0	120	54	32.5
8-7-56	46	150	54	33.5	174	60	37.5	196	84	37.0	--	--	--
8-7-56	47	54	48	32.0	126	60	37.0	84	36	37.0	--	--	--
8-7-56	48	60	84	36.0	126	36	38.5	126	30	38.5	--	--	--
8-7-56	49	60	30	38.0	126	36	39.0	120	36	38.0	--	--	--
8-16-56	42	--	60	37.0	--	--	--	108	120	40.0	96	--	40.5
8-16-56	43	78	84	41.0	--	--	--	132	78	43.0	84	66	40.5
8-16-56	46	126	138	34.0	--	--	--	132	102	37.0	120	36	35.5
8-16-56	47	84	192	38.0	96	126	42.0	--	--	--	102	210	39.5
8-16-56	48	84	174	39.0	114	72	44.5	--	--	--	114	90	43.0
8-16-56	49	78	132	42.5	108	78	45.0	--	--	--	96	132	44.5
8-16-56	51	84	66	40.0	132	102	41.0	--	--	--	90	120	41.0
8-16-56	53	84	156	39.0	90	48	42.5	--	--	--	96	48	42.0
8-20-56	42	78	54	37.5	114	30	40.5	126	30	39.5	--	--	--
8-20-56	43	78	36	38.5	126	36	42.5	126	42	41.0	--	--	--
8-20-56	46	138	42	34.0	156	48	36.5	156	54	36.0	--	--	--
8-20-56	47	78	60	36.0	120	60	40.5	102	42	40.0	--	--	--
8-21-56	49	72	24	39.0	120	30	43.0	114	42	42.5	--	--	--
8-21-56	51	84	30	38.0	174	48	42.0	120	48	43.5	--	--	--
8-21-56	53	66	54	37.5	108	42	39.5	96	48	41.0	--	--	--

Table 11. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
8-24-56	43	114	54	41.0	108	60	41.0	108	60	43.0	--	--	--
8-24-56	47	90	72	39.0	108	78	41.5	102	114	41.0	--	--	--
8-24-56	48	90	72	39.0	108	78	41.5	102	114	41.0	--	--	--
8-24-56	49	90	36	40.0	114	48	44.0	108	48	42.0	--	--	--
8-24-56	51	102	36	41.5	120	36	44.0	120	48	44.0	--	--	--
8-24-56	53	78	30	41.0	156	30	43.5	132	42	44.0	--	--	--
8-25-56	43	108	66	42.0	138	42	43.5	108	42	45.0	--	--	--
8-25-56	47	66	48	37.5	114	48	37.5	114	48	42.5	--	--	--
8-25-56	48	72	60	38.5	144	24	45.5	132	24	43.0	--	--	--
8-25-56	49	84	30	41.0	168	36	--	102	36	42.0	--	--	--

Table 12. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Atropine and Brome Grass Juice

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
42	78	57	37.3	114	30	40.5	117	75	39.8	96	--	40.5
45	102	48	32.5	--	--	--	126	54	33.0	120	54	32.5
46	138	78	33.8	165	54	37.0	161.3	80	36.7	120	36	35.5
47	74.4	84	36.5	112.8	74.4	39.7	100.5	60	40.1	102	--	39.5
48	76.5	97.5	38.1	123	52.5	42.5	120	56	40.8	114	90	43.0
49	76.8	50.4	40.1	127.2	45.6	42.8	111	40.5	41.1	96	132	44.5
51	90	44	39.8	142	62	42.3	120	48	43.7	90	120	41.0
53	76	80	39.2	118	40	41.8	114	45	42.5	96	48	42.0
AVERAGE	89	67.4	37.2	128.9	51.2	40.9	121.2	57.3	39.7	104.3	80	39.8
CHANGE				⁄39.9	-16.2	⁄3.7	⁄32.2	-10.1	⁄2.5	⁄15.3	⁄12.6	⁄2.6

Table 13. Results from Drenching Sheep with a One Percent Glucose Solution

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
6-12-56	49	72	Glucose***	2880	No unusual effects
6-12-56	50	76	Glucose***	3040	No unusual effects
6-12-56	51	66	Glucose	2640	No unusual effects
6-12-56	52	77	Glucose***	3080	No unusual effects
6-12-56	53	62	Glucose***	2480	No unusual effects
6-14-56	49	72	Glucose	2880	No unusual effects
6-14-56	50	76	Glucose	3040	No unusual effects
6-14-56	51	66	Glucose	2640	No unusual effects
6-14-56	52	77	Glucose	3080	No unusual effects
6-14-56	53	62	Glucose	2480	No unusual effects
6-26-56	49	82	Glucose*	3280	No unusual effects
6-26-56	50	83	Glucose*	3320	No unusual effects
6-26-56	51	74	Glucose*	2960	No unusual effects
6-26-56	52	84	Glucose*	3360	Died; liquid went into lungs
6-26-56	53	72	Glucose*	2880	No unusual effects
6-27-56	45	65	Glucose**	2600	No unusual effects
6-27-56	46	79	Glucose**	3160	No unusual effects
6-27-56	47	74	Glucose**	2960	No unusual effects
6-27-56	48	78	Glucose**	3120	No unusual effects
6-28-56	45	65	Glucose***	2600	No unusual effects
6-28-56	46	79	Glucose***	3160	No unusual effects

*The sheep were fasted for one day except for nourishment received from drench.
**The sheep were fasted for two days except for nourishment received from drench.
***The sheep were fasted for three days except for nourishment received from drench.

Table 13. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Treatment Amount ml.	Remarks
6-28-56	47	74	Glucose***	2960	No unusual effects
6-28-56	48	78	Glucose***	3120	No unusual effects
6-29-56	45	65	Glucose****	2600	No unusual effects
6-29-56	46	79	Glucose****	3160	No unusual effects
6-29-56	47	74	Glucose****	2960	No unusual effects
7-10-56	49	86	Glucose	3440	No unusual effects
7-10-56	51	73	Glucose	2920	No unusual effects
7-10-56	53	70	Glucose	2800	No unusual effects
7-11-56	49	86	Glucose	3440	No unusual effects
7-11-56	51	73	Glucose	2920	No unusual effects
7-11-56	53	70	Glucose	2800	No unusual effects
7-12-56	45	71	Glucose	2840	No unusual effects
7-12-56	46	84	Glucose	3360	No unusual effects
7-12-56	47	66	Glucose	2640	No unusual effects
7-13-56	45	71	Glucose	2840	Vomited over half of solution
7-13-56	47	66	Glucose	2640	No unusual effects
7-13-56	48	80	Glucose	3200	No unusual effects
8-2-56	45	62	Glucose	2450	No unusual effects
8-2-56	46	75	Glucose	3000	No unusual effects
8-2-56	47	70	Glucose	2800	No unusual effects
8-8-56	46	71	Glucose	2840	No unusual effects

****The sheep were fasted for four days except for nourishment received from drench.

Table 14. Heart Rate, Respiration Rate and Abdominal Circumference when a One Percent Glucose Solution was Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
6-12-56	49	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	50	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	51	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	52	--	--	--	--	--	--	--	--	--	--	--	--
6-12-56	53	--	--	--	--	--	--	--	--	--	--	--	--
6-14-56	49	--	--	36.0	--	--	--	--	--	38.0	--	--	--
6-14-56	50	--	--	32.5	--	--	34.0	--	--	--	--	--	--
6-14-56	51	--	--	32.5	--	--	34.0	--	--	--	--	--	--
6-14-56	52	--	--	35.5	--	--	--	--	--	35.5	--	--	35.5
6-14-56	53	--	--	35.5	--	--	--	--	--	36.0	--	--	--
6-26-56	49	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	50	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	51	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	52	--	--	--	--	--	--	--	--	--	--	--	--
6-26-56	53	--	--	--	--	--	--	--	--	--	--	--	--
6-27-56	45	--	--	34.5	--	--	35.0	--	--	--	--	--	--
6-27-56	46	--	--	33.5	--	--	--	--	--	--	--	--	37.5
6-27-56	47	--	--	35.0	--	--	38.5	--	--	--	--	--	--
6-27-56	48	--	--	--	--	--	--	--	--	--	--	--	--
6-28-56	45	--	--	32.0	--	--	35.5	--	--	--	--	--	--
6-28-56	46	--	--	34.0	--	--	--	--	--	--	--	--	37.0
6-28-56	47	--	--	32.5	--	--	--	--	--	34.5	--	--	--
6-28-56	48	--	--	34.5	--	--	--	--	--	36.5	--	--	--

Table 14. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
6-29-56	45	--	--	32.5	--	--	--	--	--	33.5	--	--	--
6-29-56	46	--	--	33.5	--	--	--	--	--	--	--	--	37.5
6-29-56	47	--	--	32.5	--	--	--	--	--	34.5	--	--	--
7-10-56	49	--	--	38.5	--	--	42.0	--	--	41.0	--	--	--
7-10-56	51	--	--	35.0	--	--	38.5	--	--	38.0	--	--	--
7-10-56	53	--	--	35.5	--	--	39.0	--	--	37.5	--	--	--
7-11-56	49	--	--	35.0	--	--	--	--	--	37.5	--	--	37.0
7-11-56	51	--	--	36.0	--	--	37.0	--	--	--	--	--	37.0
7-11-56	53	--	--	34.5	--	--	39.5	--	--	37.5	--	--	--
7-12-56	45	--	--	35.0	--	--	38.5	--	--	38.5	--	--	37.5
7-12-56	46	--	--	36.0	--	--	40.0	--	--	40.5	--	--	--
7-12-56	47	--	--	32.0	--	--	36.0	--	--	34.5	--	--	--
7-13-56	45	--	--	34.5	--	--	--	--	--	36.5	--	--	36.5
7-13-56	47	--	--	32.5	--	--	36.0	--	--	34.5	--	--	--
7-13-56	48	--	--	38.0	--	--	40.5	--	--	39.5	--	--	39.5
8-2-56	45	108	42	32.0	192	42	34.5	120	48	35.0	--	--	--
8-2-56	46	114	48	35.5	192	30	37.5	162	36	35.0	--	--	--
8-2-56	47	66	60	35.0	114	36	37.5	84	36	35.0	--	--	--
8-8-56	46	132	42	34.0	168	30	36.0	120	36	35.5	--	--	--

Table 15. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Glucose

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
45	--	--	33.7	--	--	36.3	--	--	36.2	--	--	37.0
46	--	--	34.5	--	--	36.7	--	--	37.2	--	--	--
47	--	--	33.3	--	--	37.0	--	--	35.2	--	--	--
48	--	--	36.3	--	--	40.5	--	--	38.0	--	--	39.0
49	--	--	36.5	--	--	42.0	--	--	38.8	--	--	37.0
50	--	--	34.0	--	--	38.0	--	--	--	--	--	36.0
51	--	--	34.5	--	--	36.5	--	--	38.0	--	--	37.0
52	--	--	35.5	--	--	35.5	--	--	--	--	--	35.5
53	--	--	35.2	--	--	39.3	--	--	36.8	--	--	--
AVERAGE	--	--	34.8	--	--	38.0	--	--	37.2	--	--	36.9
CHANGE						↗3.2			↗2.4			↗2.1

drenching and then gradually decreased.

Control - Atropine and One Percent Glucose Solution

Atropine plus a one percent glucose solution was the control group for atropine and alfalfa juice, and atropine and brome grass juice drenchings. Of eight sheep drenched 39 times, none bloated (Table 16). Table 17 gives the heart rate, respiration rate and abdominal circumference for each sheep. The average heart rate increased from 91.9 to 125.3 beats per minute within the first hour after drenching and then gradually decreased (Table 18). Table 18 also shows the average respiration rate decreased the first hour after drenching and then gradually increased. The greatest abdominal expansion was 2.4 inches within one hour after the drenching.

Alfalfa Juice Concentrate (10 percent solids)

Of the four sheep drenched with this concentrate, two bloated (Table 19). The physical effects from this drench were similar to the previous drenches. Table 20 shows the average heart rate increased from 99 to 114.5 beats per minute the first hour after drenching, and remained at 112.5 the next two hours. The respiration rate increased from 34.5 to 42 inhalations within the first two hours after drenching before it decreased.

Alfalfa Juice Concentrate (20 percent solids)

All four sheep drenched with 20 percent solids bloated,

Table 16. Results from Drenching Sheep with a One Percent Glucose Solution after a Subcutaneous Injection of One Grain of Atropine

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
7-24-56	49	84	Atropine & Glucose	3360	No unusual effects
7-24-56	51	76	Atropine & Glucose	3040	No unusual effects
7-24-56	53	70	Atropine & Glucose	2800	Labored breathing
7-25-56	46	72	Atropine & Glucose	2880	No unusual effects
7-25-56	47	66	Atropine & Glucose	2640	No unusual effects
7-25-56	48	84	Atropine & Glucose	3360	No unusual effects
7-27-56	49	84	Atropine & Glucose	3360	No unusual effects
7-27-56	51	76	Atropine & Glucose	3040	No unusual effects
7-27-56	53	70	Atropine & Glucose	2800	No unusual effects
7-31-56	46	75	Atropine & Glucose	3000	Weak and shaky
7-31-56	47	70	Atropine & Glucose	2800	No unusual effects
7-31-56	48	86	Atropine & Glucose	3440	No unusual effects
8-7-56	51	79	Atropine & Glucose	3160	No unusual effects
8-7-56	53	68	Atropine & Glucose	2720	No unusual effects
8-13-56	46	64	Atropine & Glucose	2560	No unusual effects
8-13-56	47	66	Atropine & Glucose	2640	No unusual effects
8-13-56	48	80	Atropine & Glucose	3200	No unusual effects
8-14-56	49	80	Atropine & Glucose	3200	No unusual effects
8-14-56	51	82	Atropine & Glucose	3280	No unusual effects
8-14-56	53	68	Atropine & Glucose	2720	No unusual effects

Table 16. (continued)

Date	Sheep	Weight lbs.	Treatment Type	Treatment Amount ml.	Remarks
8-15-56	42	64	Atropine & Glucose	2560	No unusual effects
8-15-56	43	70	Atropine & Glucose	2800	No unusual effects
8-15-56	46	64	Atropine & Glucose	2560	No unusual effects
8-17-56	42	64	Atropine & Glucose	2560	No unusual effects
8-17-56	43	70	Atropine & Glucose	2800	No unusual effects
8-20-56	48	81	Atropine & Glucose	3240	No unusual effects
8-20-56	49	81	Atropine & Glucose	3240	No unusual effects
8-20-56	51	75	Atropine & Glucose	3000	No unusual effects
8-20-56	53	73	Atropine & Glucose	2920	No unusual effects
8-21-56	42	62	Atropine & Glucose	2480	No unusual effects
8-21-56	43	70	Atropine & Glucose	2800	No unusual effects
8-21-56	46	68	Atropine & Glucose	2720	No unusual effects
8-21-56	47	68	Atropine & Glucose	2720	No unusual effects
8-21-56	48	81	Atropine & Glucose	3240	No unusual effects
8-22-56	42	62	Atropine & Glucose	2480	No unusual effects
8-22-56	43	70	Atropine & Glucose	2800	No unusual effects
8-22-56	46	68	Atropine & Glucose	2720	No unusual effects
8-25-56	51	75	Atropine & Glucose	3000	No unusual effects
8-25-56	53	73	Atropine & Glucose	2920	No unusual effects

Table 17. Heart Rate, Respiration Rate and Abdominal Circumference when Atropine and a One Percent Glucose Solution was Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
7-24-56	49	72	42	36.5	108	66	40.5	--	--	--	--	--	38.5
7-24-56	51	102	36	35.0	108	54	36.5	--	--	37.0	--	--	35.5
7-24-56	53	126	108	34.0	156	60	40.0	96	60	40.0	--	--	40.0
7-25-56	46	120	48	35.5	144	42	38.0	--	--	--	120	36	37.0
7-25-56	47	108	126	37.0	120	60	38.5	--	--	--	78	78	38.5
7-25-56	48	90	120	39.5	--	--	--	108	48	42.0	72	60	38.5
7-27-56	49	72	42	37.5	114	36	41.0	108	42	40.0	--	--	--
7-27-56	51	108	42	38.0	144	36	39.0	120	42	39.5	--	--	38.5
7-27-56	53	132	120	39.0	102	48	40.5	144	54	39.0	--	--	39.0
7-31-56	46	144	48	35.0	192	42	36.0	--	--	--	126	36	35.0
7-31-56	47	126	54	39.0	138	48	39.5	--	--	--	84	42	39.0
7-31-56	48	132	54	39.0	144	30	40.0	--	--	--	108	30	38.5
8-7-56	51	96	42	37.5	138	30	38.5	114	30	39.0	--	--	--
8-7-56	53	66	54	35.5	102	42	36.5	84	30	35.5	--	--	--
8-13-56	46	132	36	34.0	132	36	35.5	--	--	--	138	42	34.0
8-13-56	47	60	42	36.0	114	60	39.0	--	--	--	60	48	38.5
8-13-56	48	60	24	38.0	120	30	42.0	--	--	--	78	30	42.0
8-14-56	49	90	60	42.5	126	54	43.0	96	72	43.5	--	--	--
8-14-56	51	96	30	39.0	144	42	43.0	108	30	41.0	--	--	--
8-14-56	53	84	114	41.0	114	54	43.0	90	30	41.5	--	--	--

Table 17. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
8-15-56	42	84	120	36.5	--	--	--	120	72	40.0	84	120	38.0
8-15-56	43	84	42	39.0	--	--	--	120	72	40.0	78	60	40.0
8-15-56	46	114	90	35.0	138	60	36.0	--	--	--	96	60	36.0
8-17-56	42	72	132	38.0	108	42	41.5	--	--	--	90	66	39.5
8-17-56	43	78	72	38.5	120	60	41.5	84	72	41.0	--	--	--
8-20-56	48	78	36	40.0	138	36	43.0	132	36	42.0	--	--	--
8-20-56	49	84	30	38.5	90	42	42.0	84	48	42.0	--	--	--
8-20-56	51	102	30	38.5	150	42	39.0	132	36	38.0	--	--	--
8-20-56	53	84	42	39.5	84	54	39.0	84	42	37.5	--	--	--
8-21-56	42	66	102	38.0	120	66	40.0	96	42	40.0	--	--	--
8-21-56	43	72	30	39.0	138	42	42.0	102	42	41.0	--	--	--
8-21-56	46	138	66	35.5	162	54	36.5	144	66	35.5	--	--	--
8-21-56	47	66	42	37.5	120	90	41.5	90	72	42.0	--	--	--
8-21-56	48	72	42	40.5	108	54	44.0	96	42	42.5	--	--	--
8-22-56	42	--	144	37.0	108	42	41.5	--	--	--	--	--	--
8-22-56	43	84	72	39.0	120	48	41.5	--	--	--	--	--	--
8-22-56	46	156	84	35.0	156	66	36.0	--	--	--	--	--	--
8-25-56	51	90	30	39.5	162	54	41.5	120	42	40.0	--	--	--
8-25-56	53	78	48	41.5	96	36	45.0	108	42	45.0	--	--	--

Table 18. Summary of Average Heart Rate, Respiration Rate and Abdominal Circumference in Sheep Drenched with Atropine and Glucose

Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
	HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
42	74	124.5	37.4	112	50	41.0	108	57	40.0	87	93	38.8
43	79.5	54	38.9	126	50	41.7	102	62	40.7	78	60	40.0
46	133	62	35.0	154	50	36.3	144	66	35.5	120	43.5	35.5
47	88.4	66	37.4	123	64.5	39.6	90	72	42.0	74	56	38.7
48	86.4	55.2	39.4	127.5	37.5	42.2	112	42	42.2	86	40	39.6
49	79.5	43.5	38.8	109.5	49.5	41.6	96	54	41.8	--	--	38.5
51	99	35	37.9	141	43	39.6	118.8	36	39.1	--	--	37.0
53	95	81	38.4	109	49	40.7	101	43	39.8	--	--	39.5
AVERAGE	91.9	65.2	37.9	125.3	49.2	40.3	109	54	40.1	89	58.5	38.5
CHANGE				⁄33.4	-16.0	⁄2.4	⁄17.1	-11.2	⁄2.2	-2.9	-6.7	⁄.6

Table 19. Results from Drenching Sheep with Alfalfa Juice Concentrate (10 Percent Solids)

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
10-8-56	47	81	Alfalfa Juice Concentrate	3240	Slight bloat
10-8-56	48	87	Alfalfa Juice Concentrate	3480	No unusual effects
10-8-56	49	71	Alfalfa Juice Concentrate	2840	No unusual effects
10-8-56	53	77	Alfalfa Juice Concentrate	3080	Slight bloat

Table 20. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice Concentrate (10 Percent Solids) was Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
10-8-56	47	72	36	42.0	132	42	46.0	90	48	47.0	108	48	46.0
10-8-56	48	78	24	43.0	114	24	47.5	120	30	47.0	102	24	46.0
10-8-56	49	120	36	40.0	114	36	42.5	120	36	42.0	138	36	42.0
10-8-56	53	126	42	41.0	108	54	44.5	120	54	46.5	102	48	46.0
AVERAGE		99	34.5	41.5	117	39	45.1	112.5	42	45.6	112.5	39	45.0
CHANGE					≠18	≠4.5	≠3.6	≠13.5	≠7.5	≠4.1	≠13.5	≠4.5	≠3.5

and sheep no. 49 died approximately three hours after the drench was given (Table 21). The exact cause of death was not determined, however extreme dyspnea was noted. Table 22 shows that sheep no. 49 had increased eight inches in abdominal circumference which is considerably more when compared to the other three sheep--and even when compared to all other drenchings. The severity of bloat appeared to be slightly more from this drench than from the previous drenchings.

Alfalfa Juice Concentrate Treated with Cholesterol

The two sheep drenched with this mixture bloated as shown in Table 23. Their abdominal circumference continued to expand for six hours following the drench (Table 24). The heart rate and respiration rate were also greatly increased as the sheep became bloated.

Penicillin

A total of 34 drenchings of alfalfa juice was given to four sheep that were known to bloat nearly 100 percent of the time. Each sheep was drenched with alfalfa juice on consecutive days until it bloated (Table 25). When the sheep bloated, they were given another dose of penicillin. Table 26 indicates the number of bloated and non-bloated animals for six days following a single dose of 25 mg. of procaine penicillin.

Sheep no. 49 was the only animal for which penicillin was effective more than two days. However, when this sheep

Table 21. Results from Drenching Sheep with Alfalfa Juice Concentrate (20 Percent Solids)

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
10-9-56	47	81	Alfalfa Juice Concentrate	3240	Slight bloat
10-9-56	48	87	Alfalfa Juice Concentrate	3480	Slight bloat
10-9-56	49	71	Alfalfa Juice Concentrate	2840	Slight bloat; died three hours after drench
10-9-56	53	77	Alfalfa Juice Concentrate	3080	Slight bloat

Table 22. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice Concentrate (20 Percent Solids) was Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
10-9-56	47	66	36	42.5	144	54	49.0	108	42	48.0	114	54	48.0
10-9-56	48	66	24	44.0	84	54	51.0	132	42	48.0	108	48	49.0
10-9-56	49	132	48	39.0	192	56	43.5	156	42	45.0	204	48	47.0
10-9-56	53	66	42	42.0	144	84	49.0	114	120	47.5	120	42	47.0
AVERAGE		82.5	37.5	41.9	141	62	48.1	127.5	61.5	47.1	136.5	48	47.7
CHANGE					≠58.5	≠24.5	≠6.2	≠45.0	≠24.0	≠5.2	≠54.0	≠10.5	≠5.8

Table 23. Results from Drenching Sheep with Alfalfa Juice Concentrate Treated with Cholesterol

Date	Sheep	Weight lbs.	Treatment Type	Amount ml.	Remarks
10-11-56	47	81	Cholesterol Treated	3240	Slight bloat
10-11-56	48	87	Cholesterol Treated	3480	Slight bloat

Table 24. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice Concentrate Treated with Cholesterol was Administered

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
10-11-56	47	66	54	41.0	96	36	46.0	84	36	46.0	102	36	47.5
10-11-56	48	54	42	44.0	84	30	46.0	84	36	46.5	84	36	47.5
AVERAGE		60	48	42.5	90	33	46.0	84	36	46.2	93	36	47.5
CHANGE					⁄30	-15	⁄3.5	⁄24	-12	⁄3.7	⁄33	-12	⁄5.0

Date	Sheep	Between 3 & 4 Hrs. After Drench HR	RR	AC	Between 4 & 5 Hrs. After Drench HR	RR	AC	Between 5 & 6 Hrs. After Drench HR	RR	AC	Between 6 & 7 Hrs. After Drench HR	RR	AC
10-11-56	47	120	54	48.0	84	48	49.5	138	144	50.5	150	180	50.5
10-11-56	48	90	30	49.0	108	30	49.5	180	108	51.0	156	150	50.5
AVERAGE		105	42	48.5	96	39	49.5	159	126	50.7	153	165	50.5
CHANGE		⁄45	-6	⁄6.0	⁄36	-9	⁄7.0	⁄99	⁄78	⁄8.2	⁄93	⁄117	⁄8.0

*Prevented bloat for one day.
**Prevented bloat for two days.
***Prevented bloat for three days.
****Prevented bloat for four days.

Table 25. Results from Drenching Sheep with Alfalfa Juice after being Treated with 25 mg. of Penicillin

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
8-27-56	47	72	Alfalfa Juice	2880	No bloat*
8-27-56	48	84	Alfalfa Juice	3360	No bloat*
8-27-56	49	78	Alfalfa Juice	3120	No bloat*
8-27-56	53	74	Alfalfa Juice	2960	No bloat*
8-28-56	47	72	Alfalfa Juice	2880	No bloat**
8-28-56	48	84	Alfalfa Juice	3360	No bloat**
8-28-56	49	78	Alfalfa Juice	3120	No bloat**
8-28-56	53	74	Alfalfa Juice	2960	Bloated on 2nd day
8-29-56	47	72	Alfalfa Juice	2880	Bloated on 3rd day
8-29-56	48	84	Alfalfa Juice	3360	Bloated on 3rd day
8-29-56	49	78	Alfalfa Juice	3120	No bloat***
8-29-56	53	74	Alfalfa Juice	2960	Bloated on 1st day
8-30-56	47	72	Alfalfa Juice	2880	No bloat*
8-30-56	48	84	Alfalfa Juice	3360	Bloated on 1st day
8-30-56	49	78	Alfalfa Juice	3120	No bloat****
8-30-56	53	74	Alfalfa Juice	2960	Bloated on 1st day
8-31-56	47	72	Alfalfa Juice	2880	Bloated on 2nd day
8-31-56	48	84	Alfalfa Juice	3360	No bloat*
8-31-56	49	78	Alfalfa Juice	3120	Bloated on 5th day
8-31-56	53	74	Alfalfa Juice	2960	No bloat*

*Prevented bloat for one day.
**Prevented bloat for two days.
***Prevented bloat for three days.
****Prevented bloat for four days.

Table 25. (continued)

Date	Sheep	Weight lbs.	Treatment		Remarks
			Type	Amount ml.	
9-1-56	47	72	Alfalfa Juice	2880	Bloated on 3rd day
9-1-56	48	84	Alfalfa Juice	3360	Bloated on 2nd day
9-1-56	49	78	Alfalfa Juice	3120	Bloated on 6th day
9-1-56	53	74	Alfalfa Juice	2960	Bloated on 2nd day
9-5-56	47	77	Alfalfa Juice	3080	No bloat*
9-5-56	48	93	Alfalfa Juice	3720	Bloated on 1st day
9-5-56	49	83	Alfalfa Juice	3320	No bloat*
9-5-56	53	78	Alfalfa Juice	3120	No bloat*
9-6-56	47	77	Alfalfa Juice	3080	No bloat**
9-6-56	48	93	Alfalfa Juice	3720	Bloated on 2nd day
9-6-56	49	83	Alfalfa Juice	3320	Bloated on 2nd day
9-6-56	53	78	Alfalfa Juice	3120	No bloat**
9-7-56	47	77	Alfalfa Juice	3080	Bloated on 3rd day
9-7-56	53	78	Alfalfa Juice	3120	Bloated on 3rd day

received a second treatment of penicillin, it prevented bloat for only one day. Table 27 shows the average heart rate increased from 78.8 to 107.4 beats per minute the first hour after drenching and remained at this rate the following two hours. The respiration rate decreased from 59 to 51 inhalations per minute the first hour after drenching and then increased slightly the next hour.

Table 26. Effectiveness of Penicillin

Days after Penicillin Treatment	Bloated	Non-bloated
1	4	10
2	6	5
3	5	1
4	0	1
5	1	0
6	1	0
Total Number of Drenchings	17	17

Temperature, Humidity and Chemical Analyses

The temperature and humidity are shown on Table 28 for the days of drenching. Table 28 also shows the amount of solids, sugars and proteins for brome grass juice and alfalfa juice. Brome grass juice had considerably less solids, sugars and proteins than did alfalfa juice (Table 28). The percent of solids in alfalfa revealed that bloat occurred when the solids dropped as low as 5 percent; however, bloat was more consistent when there were 10 percent or more solids.

Table 27. Heart Rate, Respiration Rate and Abdominal Circumference when Alfalfa Juice and Penicillin were Administered

Date	Sheep	Before Drench			Within 1 Hr. After Drench			Between 1 & 2 Hrs. After Drench			Between 2 & 3 Hrs. After Drench		
		HR	RR	AC	HR	RR	AC	HR	RR	AC	HR	RR	AC
8-27-56	47	78	54	35.5	90	42	39.0	102	138	39.5	--	--	--
8-27-56	48	60	48	40.0	72	24	42.5	78	30	42.5	--	--	--
8-27-56	49	72	30	37.5	90	24	40.5	96	24	40.0	--	--	--
8-27-56	53	72	132	40.0	114	42	41.0	108	114	42.5	--	--	--
8-28-56	47	60	102	37.0	84	78	39.0	78	156	40.0	90	96	40.0
8-28-56	48	60	108	40.0	72	36	43.0	102	96	42.0	132	156	43.5
8-28-56	49	84	48	40.0	120	30	42.0	132	48	43.5	120	96	43.0
8-28-56	53	90	144	39.0	108	102	43.5	168	180	46.5	120	168	44.5
8-29-56	47	66	66	37.0	108	72	43.5	114	84	44.0	--	--	43.0
8-29-56	48	90	114	42.0	114	66	47.5	126	72	47.0	--	--	--
8-29-56	49	84	60	39.0	120	42	42.5	108	42	43.5	--	--	--
8-29-56	53	84	150	39.5	90	84	44.0	108	138	46.5	--	--	44.5
8-30-56	47	60	66	35.5	90	132	41.5	90	138	42.0	--	--	--
8-30-56	48	72	108	40.0	108	60	44.5	108	78	44.5	--	--	--
8-30-56	49	96	48	39.0	114	48	45.0	120	54	43.0	--	--	--
8-30-56	53	84	180	39.0	108	120	45.5	126	84	44.5	--	--	--
8-31-56	47	72	120	38.0	90	96	45.0	90	72	45.0	--	--	--
8-31-56	48	96	108	41.0	96	54	46.0	84	54	46.0	--	--	--
8-31-56	49	96	42	38.0	114	36	44.0	114	36	44.5	--	--	--
8-31-56	53	84	72	39.5	114	48	43.0	114	66	43.0	--	--	--

Table 27. (continued)

Date	Sheep	Before Drench HR	RR	AC	Within 1 Hr. After Drench HR	RR	AC	Between 1 & 2 Hrs. After Drench HR	RR	AC	Between 2 & 3 Hrs. After Drench HR	RR	AC
9-1-56	47	60	84	35.0	132	36	41.5	120	42	40.0	--	--	--
9-1-56	48	72	24	39.0	84	30	45.5	96	30	45.5	--	--	--
9-1-56	49	96	36	38.0	102	30	42.0	114	24	43.5	--	--	--
9-1-56	53	66	36	37.0	108	36	42.5	120	48	45.0	--	--	--
9-5-56	47	72	36	39.5	102	72	43.0	96	90	43.0	96	36	43.0
9-5-56	48	78	24	41.0	96	30	47.5	90	36	46.0	96	30	46.0
9-5-56	49	96	36	39.5	156	30	41.0	114	30	42.5	114	30	42.0
9-5-56	53	78	30	40.5	108	24	42.5	102	42	43.0	102	48	43.5
9-6-56	47	72	42	40.0	96	30	43.5	96	30	44.0	96	66	44.5
9-6-56	48	102	30	43.5	102	30	48.5	90	30	48.5	120	48	47.5
9-6-56	49	114	30	41.0	162	30	44.0	150	30	46.5	156	30	46.5
9-6-56	53	78	30	40.0	114	30	44.0	108	30	44.5	96	42	44.5
9-7-56	47	72	60	38.0	132	42	42.5	114	54	45.0	90	42	44.0
9-7-56	53	66	48	40.0	144	48	42.0	96	30	43.5	90	30	46.0
AVERAGE		78.8	59	39.0	107.4	51	43.3	108	66.1	43.8	108.4	65.6	44.1
CHANGE					+28.6	-8	+4.3	+29.2	+7.1	+4.8	+29.6	+6.6	+5.1

Table 28. Temperature, Humidity and Chemical Analyses

Date	Temp.	Humidity	Sample	Percent Solids	Sugars		Total Protein gm/100 ml.	Non-heat ppt. Protein gm/100 ml.
					Reducing	Non-reducing		
6-12-56	--	--	Alfalfa	14.78	1.0400	0.0190	5.1125	------
6-14-56	--	--	Alfalfa	8.55	0.8010	0.0608	2.7625	1.6813
6-26-56	--	--	Alfalfa	7.83	0.6670	0.0022	2.3828	1.5750
6-27-56	--	--	Alfalfa	7.71	------	------	2.3281	------
6-28-56	--	--	Alfalfa	10.96	1.0318	------	3.4750	1.4625
6-29-56	--	--	Alfalfa	9.89	------	------	------	------
7-10-56	--	--	Alfalfa	11.79	------	------	------	------
7-11-56	--	--	Alfalfa	12.25	1.4053	0.2813	3.0188	1.8738
7-12-56	--	--	Alfalfa	12.54	------	------	3.9688	------
7-13-56	--	--	Alfalfa	12.72	1.0093	0.0904	4.5938	1.9234
7-17-56	--	--	Brome	6.70	0.6130	0.4401	0.7750	0.7750
7-24-56	78	52	Alfalfa	5.54	1.1370	0.0504	4.1438	1.7344
7-25-56	77	61	Alfalfa	8.92	1.0700	0.0656	3.2625	1.9250
7-27-56	72	66	Alfalfa	8.71	1.2290	0.0608	2.5200	1.7188
7-31-56	69	73	Alfalfa	14.61	1.5730	0.0675	3.8125	2.5200
8-1-56	71	70	Brome	4.35	0.4791	------	1.2700	0.9481
8-2-56	72	81	Brome	4.00	0.0141	------	1.3013	0.9398
8-6-56	73	74	Brome	3.71	0.5201	------	0.9813	0.7375
8-7-56	78	72	Brome	4.31	------	------	------	------
8-8-56	75	73	Brome	4.15	0.7324	0.0123	1.1113	0.7219
8-9-56	76	64	Brome	3.78	0.4993	0.0046	1.1000	0.8313
8-13-56	77	63	Alfalfa	4.88	------	------	------	------
8-14-56	78	70	Alfalfa	4.98	------	------	------	------

Table 28. (continued)

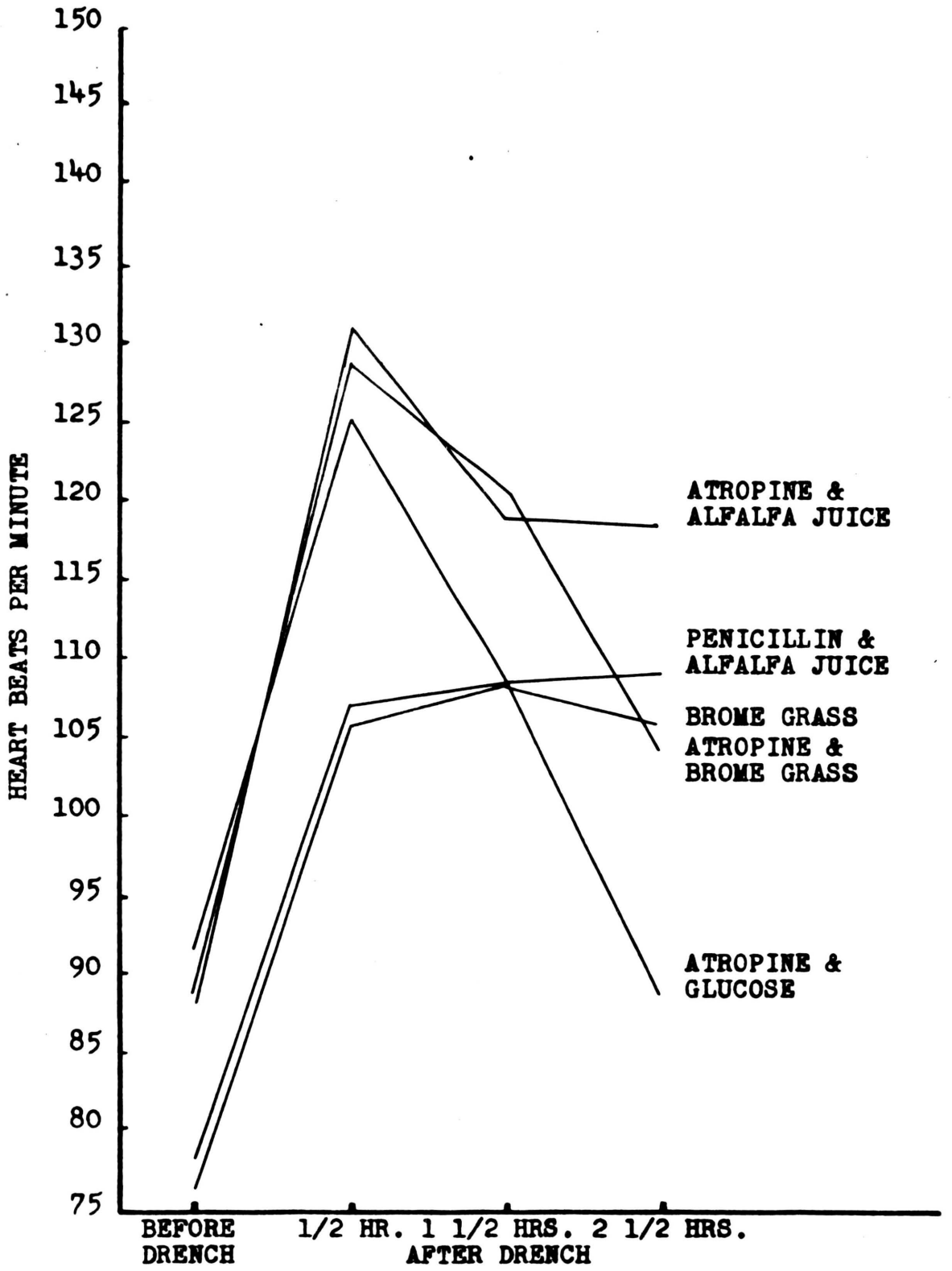
Date	Temp.	Humidity	Sample	Percent Solids	Sugars		Total Protein gm/100 ml.	Non-heat ppt. Protein gm/100 ml.
					Reducing	Non-reducing		
8-15-56	80	63	Alfalfa	10.81	------	------	------	------
8-16-56	77	61	Brome	3.92	0.4422	0.0650	1.1625	0.7750
8-17-56	81	65	Alfalfa	9.25	------	------	------	------
8-20-56	67	64	Brome	4.95	------	------	------	------
8-21-56	71	61	Brome	6.09	------	------	------	------
8-22-56	68	73	Alfalfa	10.49	------	------	------	------
8-23-56	70	66	Alfalfa	11.77	------	------	------	------
8-24-56	69	63	Brome	5.13	------	------	------	------
8-25-56	69	63	Brome	-----	------	------	------	------

Summary of Heart Rate, Respiration Rate and Abdominal Circumference from Drenchings

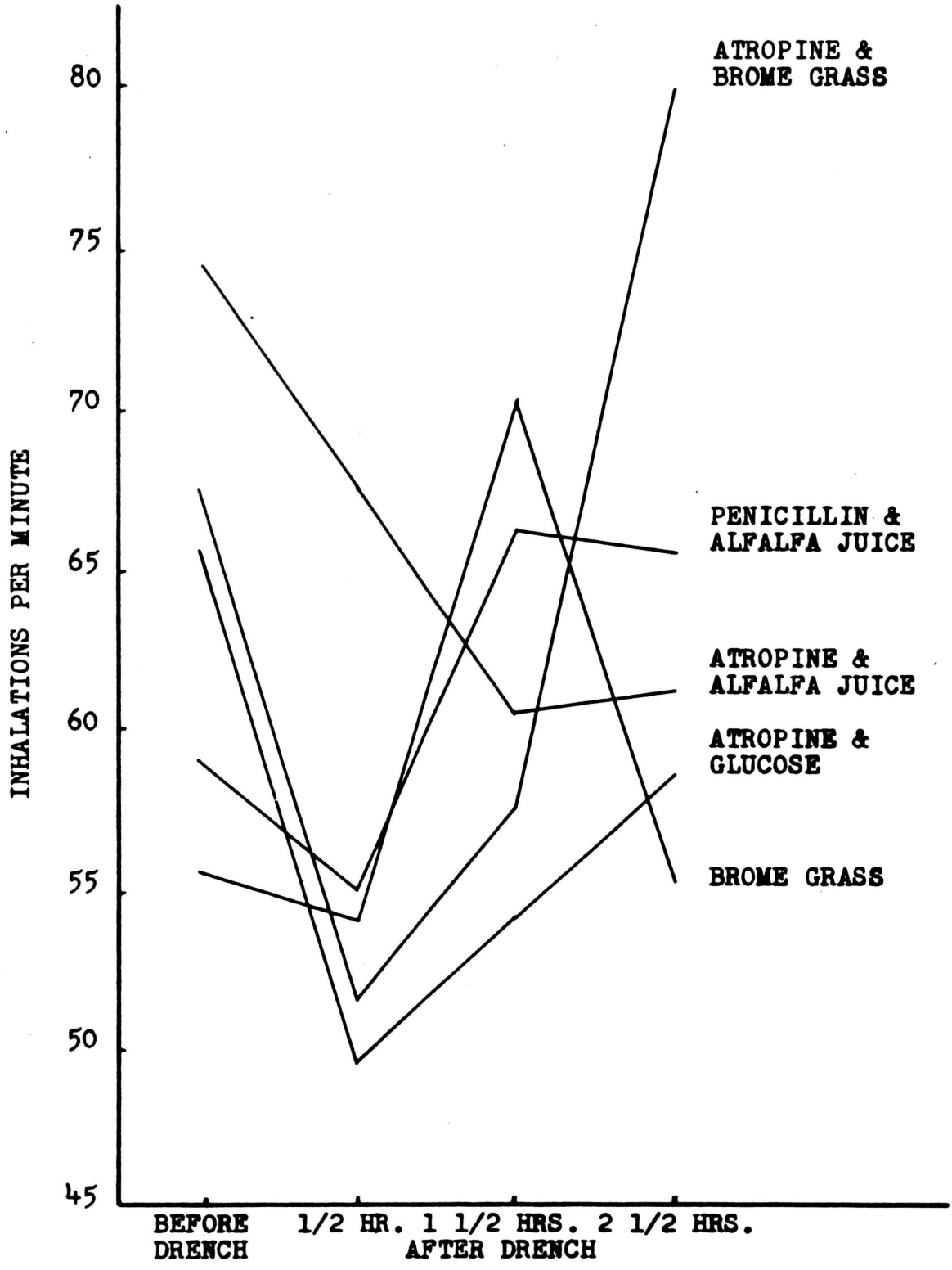
The comparison of the average heart rate for each drenching is shown on Graph 1. The heart rate increased within the first hour after drenching and then either decreased or continued at about the same rate. Analysis of variance revealed no significant difference between the heart rates of the various drenchings.

The average respiration rate from each type of drench decreased within the first hour after drenching and then increased the next hour except in the case of atropine and alfalfa juice where it continued to decrease (Graph 2). Analysis of variance showed no significant difference between the various types of drenchings.

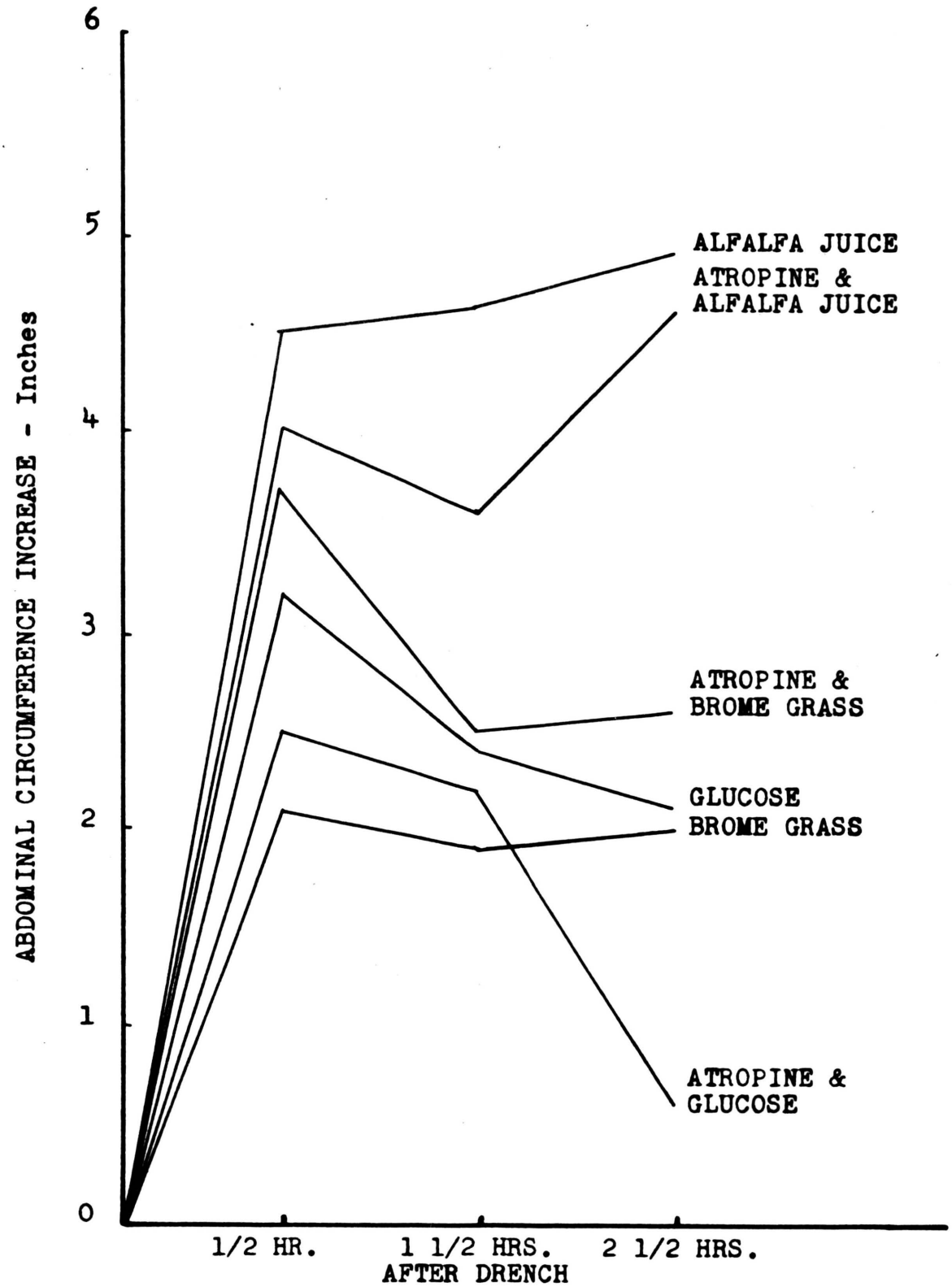
The average abdominal expansion reached a maximum the first hour after drenching except in the case of alfalfa juice and atropine plus alfalfa juice where the maximum was reached approximately three hours after the drenching (Graph 3). Analysis of variance indicated the difference between the increases of each type of drench was highly significant.



Graph 1. Comparison of Average Heart Beats



Graph 2. Comparison of Average Respiration Rate



Graph 3. Comparison of Average Abdominal Circumference

DISCUSSION OF RESULTS

These data suggest that the possibility of producing slight bloat experimentally by drenching sheep can be accomplished; however, severe bloat is seldom produced. Furthermore, these experiments, although limited, suggest that a factor capable of causing bloat is present in alfalfa juice and not in brome grass juice. This factor probably is not present in alfalfa all of the time.

The administration of one grain of atropine before the drenchings of alfalfa juice resulted in an increased incidence of bloat. For example, 31.8 percent bloat was obtained without the administration of atropine as compared to 59.5 percent when atropine was given before the drench. This would suggest that when the rumen motility and eructation are inhibited, a greater accumulation of gas results. Even though slight bloat was produced, none of the animals bloated enough to warrant concern about their health. Apparently the accumulation of gas was not enough from either normal fermentation of alfalfa juice, brome grass juice, or an adequate supply of glucose to create a pressure great enough to cause severe distress.

Evidence is presented suggesting that a factor capable of causing bloat is present in alfalfa. The concentrated fraction of alfalfa juice containing 20 percent solids produced more cases of bloat of greater severity than alfalfa

juice concentrate containing 10 percent solids.

A previous study has suggested that cholesterol when added to an alfalfa extract, precipitates the alfalfa saponins thereby facilitating study of the role of saponins in bloat (9). However, when a similar study was conducted at this station, it was found that the saponins were not precipitated because the foaming ability was not altered by the addition of cholesterol. The sheep receiving this alfalfa concentrate treated with cholesterol produced some of the most severe cases of bloat. Therefore, the alfalfa saponins were believed to be still present and could be an important factor in bloat.

The preliminary study on the effectiveness of penicillin indicated penicillin was only fairly effective one day for preventing bloat. These trials are too limited to determine the absolute effectiveness of penicillin. Inasmuch as only one level of penicillin was used, more conclusive evidence might be obtained by using higher levels of penicillin.

The decreased respiration rate and the marked increase in heart rate during the first hour after the drenching occurred at the time the ruminal distention was the greatest. In most cases, after two hours the heart rate and abdominal expansion were reduced and the respiration rate increased. Whether or not any significance can be placed on the decreased respiratory rate and the increased heart rate during the greatest ruminal distention is only problematical. There is little doubt that during ruminal distention a certain amount of CO_2

was being produced; thereby increasing the heart rate so as to increase the rate of CO_2 expelled through the lungs.

Evidence from the percent solids in alfalfa juice and concentrated alfalfa juice would suggest the amount of solids in a plant might possibly be a factor causing bloat. The sugars and proteins, on the other hand, appeared to be of little significance. More data are needed to confirm the effect of solids.

SUMMARY AND CONCLUSIONS

1. The administration of atropine before drenching with alfalfa juice resulted in producing more bloat than without atropine.
2. None of the animals bloated when drenched with brome grass juice, one percent glucose solution, or when these drenches were given in combination with an injection of atropine.
3. Only slight bloat was produced from alfalfa juice drenchings. Alfalfa juice administered at the rate of nine percent of the body weight in the experiments reported did not contain a factor severe enough to cause bloat, nor to consistently produce slight bloat in all animals.
4. Alfalfa juice concentrate containing 20 percent solids was capable of producing a higher degree of bloat than that containing 10 percent solids. This fact and the fact that a greater incidence of bloat occurred from alfalfa juice when it contained over 10 percent solids would support the theorem that a plant factor is involved in bloat.
5. Alfalfa juice concentrate treated with cholesterol did not prevent bloat, but rather produced some of the most severe cases.
6. There appeared to be no relationship among sugars, proteins, temperature and humidity toward the production

or incidence of bloat.

7. The increased heart rate and decreased respiration rate in most of the sheep within one hour after drenching could not be accounted for at this time.

LITERATURE CITED

(1) Alston, J. T., and Stephens, C. Useful Prescriptions. No. 4. For bloat in cattle. Vet. Med. 35:312. 1940.

(2) Anderson, K. L. Prevent bloat with rationed grazing. Hoard's D. 98:278. 1955.

(3) Anonymous. Annual Report of Cooperative Regional Projects. P. 1. (Mar. 17) 1956.

(4) Barcroft, J., McAnally, R. A., and Phillipson, A. T. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(5) Barker, H. A., Ruben, S., and Kamen, M. D. The reduction of radioactive carbon dioxide by methane producing bacteria. Proc. Nat. Acad. Sci. 26:426-430. 1940.

(6) Barker, H. A., cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(7) Barrentine, B. F. Penicillin-salt mix stops bloat. Farm J. 81:45-46. 1957.

(8) Barrentine, B. F., Shauver, C. B., and Williams, L. W. Antibiotics for the prevention of bloat in cattle grazing ladino clover. J. Animal Sci. 15:440-446. 1956.

(9) Blake, J. T. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(10) Carroll, E. J., and Hungate, R. E. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(11) Clark, R. Studies on the alimentary tract of Merino sheep in South Africa. XIV. The effect of some commonly used antifermentatives on the in vitro formation of gas in ruminal ingesta and its bearing on the pathogenesis of bloat. Onderstepoort J. Vet. Sci. Animal Ind. 23:389-393. 1948.

(12) Clark, R. The use of anti-frothing agents in the treatment of acute bloat. J. South African Vet. Med. Assoc. 21:173-178. 1950.

(13) Clark, C. H. The nerve control of rumination and reticulo-ruminal motility. Am. J. Vet. Research. 14:376-384. 1953.

(14) Clark, R., and Lombard, W. A. Studies on the alimentary tract of Merino sheep in South Africa. XXII. The effect of the pH of the ruminal contents on ruminal motility. Onderstepoort J. Vet. Res. 25:79-92. 1951.

(15) Clark, R., Oyaert, W., and Quin, J. I. Studies on the alimentary tract of the Merino sheep in South Africa. XXI. The toxicity of urea to sheep under different conditions. Onderstepoort J. Vet. Res. 25:73-78. 1951.

(16) Clark, R., and Quin, J. I. Studies on the alimentary tract of Merino sheep in South Africa. XIII. The role of prussic acid in the aetiology of acute bloat. Onderstepoort J. Vet. Sci. Animal Ind. 20:209-212. 1945.

(17) Clark, R., and Weiss, K. E. Factors contributing towards bloat in ruminants. Onderstepoort J. S.A.V.M.A. 23:103-106. 1952.

(18) Clark, R., and Weiss, K. E. Reflex salivation in sheep and goats initiated by mechanical stimulation of the cardiac area of the forestomachs. J. South Africa Vet. Med. Assoc. 23:163. 1952.

(19) Cole, H. H. Chemical and physical factors in the etiology of acute bloat on legume pasture. Proc. Conference on Rumen Function. Chicago. 1952.

(20) Cole, H. H., and Kleiber, M. Studies on ruminal gas formation and on consumption of alfalfa pasture by cattle. J. Dairy Sci. 31:1016-1023. 1948.

(21) Cole, H. H., Mead, S. W., and Kleiber, M. Bloat in cattle. Calif. Agr. Expt. Sta. Bull. 662. 1942.

(22) Cole, H. H., Mead, S. W., and Regan, W. M. Production and prevention of bloat in cattle on alfalfa pasture. J. Animal Sci. 2:285-294. 1943.

(23) Cole, H. H., Huffman, C. F., Kleiber, M., Olson, T. M., and Schalk, A. F. A review of bloat in ruminants. J. Animal Sci. 4:183-236. 1945.

(24) Cole, H. H., Dougherty, R. W., Huffman, C. F., Hungate, R. E., Kleiber, M., and Maclay, W. D. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(25) Dain, J. A., Neal, A. L., and Dougherty, R. W. The occurrence of histamine and tyramine in rumen ingesta of experimentally over-fed sheep. J. Animal Sci. 14:930-935. 1955.

(26) Delmer, A. Acute meteorism of ruminants. Am. J. Vet. Med. 15:494. 1920.

(27) Dougherty, R. W. Further investigations of rumen gases and bloat in ruminants. J. Am. Vet. Med. Assoc. 99:110-114. 1941.

(28) Dougherty, R. W. A study of drugs affecting the motility of the bovine rumen. Cornell Vet. 32:269-280. 1942.

(29) Dougherty, R. W. The continuing quest for the cause of bloat in ruminants. J. Am. Vet. Med. Assoc. 122:914. 1953.

(30) Dougherty, R. W., and Meredith, C. D. Antifoaming (defrothing) agents in the treatment and prevention of bloat. J. Am. Vet. Med. Assoc. 124:474-475. 1954.

(31) Dougherty, R. W., and Meredith, C. D. Cinefluorographic studies of the ruminant stomach and of eructation. Am. J. Vet. Research. 16:96-100. 1955.

(32) Dracy, A. E. The effect of atropine on the gas accumulation of the normal ruminant. Proc. S. D. Acad. Sci. 34:121-123. 1955.

(33) Dracy, A. E., Jordan, R. M., and Shaffhausen, D. D. The effect of clamping the esophagus upon gas accumulation in the rumen and the well-being of sheep. Proc. S. D. Acad. Sci. 33:175-177. 1954.

(34) Dracy, A. E., and Jordan, R. M. Unpublished data.

(35) Dukes, H. H. The physiology of Domestic Animals. 7th Ed. Comstock Publishing Company, Inc., Ithaca, N. Y. 1955.

(36) Ellenberger, W. Cited by Weiss. Physiological Studies on eructation in ruminants. Onderstepoort J. Vet. Res. 26:251-283. 1953.

(37) Elsden, S. R. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(38) Espe, D. H., Jacobson, N. L., and Cannon, C. Y. Why do cows bloat? Holstein Friesian World. 40:1020. 1943.

(39) Evans, W. C., and Evans, E. T. R. Relation of a clover juice factor causing paralysis of smooth muscle to bloat in ruminants. Nature. 163:173-377. 1949.

(40) Ferguson, T. H., and Ferguson, S. E. Acute bloating in cattle. North Am. Vet. 15:27-29. 1934.

(41) Ferguson, W. S. A factor in pastures affecting muscle activity. Grassland Conference Handbook. PP. 1-11. 1948.

(42) Ferguson, W. S. A possible relation between the action of clover juice on isolated muscle and "bloat" in cattle. Nature. 161:816-817. 1948.

(43) Ferguson, W. S., Ashworth, De B., and Terry, R. A. Nature of muscle - inhibiting compound in Lucerne and its possible connection with bloat in cattle. Nature. 163:606. 1949.

(44) Ferguson, W. S., Ashworth, De B., and Terry, R. A. Identity of muscle - inhibiting flavone in Lucerne. Nature. 166:116. 1950.

(45) Grayson, A. R. Bloating in cattle. J. Victoria Australia Agr. Dept. 51:404-406. 1953.

(46) Hale, W. H., and King, R. P. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(47) Hassid, W. Z. Determination of reducing sugars and sucrose in plant materials. Ind. Eng. Chem. Anl. Ed. 9:228-229. 1937.

(48) Hungate, R. E., Dougherty, R. W., Bryant, M. P., and Cello, R. M. Microbiological and physiological changes associated with acute indigestion in sheep. Cornell Vet. 42:423-449. 1952.

(49) Jacobson, N. L., Espe, D., and Cannon, C. Y. Factors modifying the rate of fermentation of ingesta and their possible relation to bloat in dairy cattle. J. Dairy Sci. 25:785-799. 1942.

(50) Johns, A. T. Bloat in cattle on red clover. Part I. New Zealand J. Sci. Tech. 36:289-320. 1955.

(51) Johns, A. T. Bloat. Vet. Reviews and Annotations. 2:107-134. 1956.

(52) Kellner, O., and Kohler, A. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(53) Kerr, W. R., and Lamont, H. G. Hoven - An expression of allergy. Vet. Record. 58:6-7. 1946.

(54) Kjeldahl, J. Z. Anal. Chem. 22:366. 1883.

(55) Kleiber, M., Cole, H. H., and Mead, S. W. Bloat in cattle and composition of rumen gases. J. Dairy Sci. 26:929-933. 1943.

(56) Lindahl, I. L., Cook, A. C., Davis, R. E., and Maclay, W. D. Preliminary investigations on the role of alfalfa saponin in ruminant bloat. Science. 119:157-158. 1954.

(57) Mangold, E., and Klein, W. Cited by Blake. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(58) Markoff, I. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(59) Mc Gaughey, C. A., and Sellers, K. C. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(60) Mead, S. W., Cole, H. H., and Regan, W. M. Further studies on bloat. J. Dairy Sci. 27:779-791. 1944.

(61) Mitchell, H. H., Hamilton, T. S., and Haines, W. T. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(62) Moore, G. R. Some clinical uses of a new antihistamine. Vet. Med. 45:328-329. 1950.

(63) Neuberg, C., and Orinstein, B. Cited by Blake, J. T. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(64) Nichols, R. E. A note on the comparison of gases from spontaneous and rumen fermentation of certain feedstuffs. Am. J. Vet. Res. 8:391-395. 1947.

(65) Nichols, R. E. A note on eructation in sheep as related to rumen fluid level and gas insufflation. Am. J. Vet. Res. 12:199-200. 1951.

(66) Nichols, R. E. Cited by Myren, D. Detergents and a new theory on bloat. Hoard's D. 98:942. 1953.

(67) Nichols, R. E. How detergents prevent bloat. Am. Vet. Med. Assoc. J. 124:35. 1954.

(68) Nichols, R. E. Why do cows and sheep bloat? Vet. Med. 49:91-95. 1954.

(69) Olson, T. M. Ruminal gases in normal and bloated animals. (Abs.) J. Dairy Sci. 25:684-685. 1942.

(70) Olson, T. M. Bloat in dairy cattle. S. D. Agr. Exp. Circ. 52:1-11. 1944.

(71) Olson, T. M., and Breazeale, D. F. Unpublished data. 1944.

(72) Osterli, V. P., and Peterson, M. L. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(73) Oyaert, W., Quin, J. I., and Gark, R. Studies on the alimentary tract of the Merino sheep in South Africa. XIX. The influence of sulphanilamide on the activity of the ruminal flora of sheep and cattle. Onderstepoort J. Vet. Res. 25:59-65. 1951.

(74) Parsons, A. R. Isolated gut and motility as affected by forage juice and other related substances. Proc. Conference on Rumen Function. Chicago. 1953.

(75) Parsons, A. R., Hall, G., and Thomas, W. E. Forage extracts which cause bloat or death when administered orally to sheep. (Abs.) J. Animal Sci. 11:772-773. 1952.

(76) Parsons, A. R., Whitehair, C. K., and Neumann, A. L. Bloat and rumen motility as affected by forage extracts and other related substances. (Abs.) J. Animal Sci. 12:926-927. 1953.

(77) Phillipson, A. T. Cited by Blake, J. T. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(78) Quin, A. H. New approach to the treatment of bloat in ruminants. Am. Vet. Med. Assoc. J. 114:313-314. 1949.

(79) Quin, J. I. Studies on the alimentary tract of Merino sheep in South Africa. VII. Fermentation of the forestomachs of sheep. Onderstepoort J. Vet. Sci. Animal Ind. 18:91-112. 1943.

(80) Quin, J. I. Studies on the alimentary tract of Merino sheep in South Africa. VIII. The pathogenesis of acute tympanites (bloat). Onderstepoort J. Vet. Sci. Animal Ind. 18:113-118. 1943.

(81) Rau, E. The influence of turpentine on the stomachs of ruminants. Am. J. Vet. Med. 11:215. 1916.

(82) Reid, C. S. W. Cited by Johns, A. T. Bloat. Vet. Reviews and Annotations. 2:107-134. 1956.

(83) Reid, C. S. W., and Johns, A. T. Cited by Johns, A. T. Bloat. Vet. Reviews and Annotations. 2:107-134. 1956.

(84) Schalk, A. F. We're finding answers to the bloat problem. Successful Farming. 43:66. 1945.

(85) Smith, C. K., Brunner, J. R., Huffman, C. F., and Duncan, C. W. Experimental production of frothy bloat in cattle. (Abs.) J. Animal Sci. 12:932. 1953.

(86) Smith, C. K., and Huffman, C. F. Frothy bloat. Proc. Conference on Rumen Function. Chicago. P. 7. 1953.

(87) Symons, G. E., and Buswell, A. M. Cited by Blake, J. T. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(88) Thomas, W. E. Proc. Conference on Rumen Function. Chicago. P. 3. 1951.

(89) Thomas, W. E. Bloat can be prevented. Farm Q. 8:64. 1953.

(90) Washburn, L. E., and Brody, S. Methane, hydrogen, and carbon dioxide production in the digestive tract of ruminants in relation to the respiratory exchange. Mo. Agr. Expt. Sta. Res. Bull. 263. 1937.

(91) Weiss, K. E. Physiological studies on eructation in ruminants. Onderstepoort J. Vet. Res. 26:251-283. 1953.

(92) Weiss, K. E. The significance of reflex salivation in relation to froth formation and acute bloat in ruminants. Onderstepoort J. Vet. Res. 26:241-250. 1953.

(93) Wester, J. Cited by Cole, et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.

(94) Woodman, H. E., and Evans, R. E. Cited by Blake, J. T. Evaluation of various physical and nutritional factors related to bloat. Ph.D. Thesis. Iowa State College. 1955.

(95) Woods, D. D., and Clifton, C. E. Cited by Cole et al. A review of bloat in ruminants. Nat. Acad. Sci. - Nat. Res. Council Pub. 388. 1955.