LIQUID MOLASSES SUPPLEMENTS AS CARRIERS FOR POLOXALENE FOR THE CONTROL OF PASTURE BLOAT

by 5791

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INTRODUCTION

Bloat in cattle, characterized by an abnormal distention of the ruminoreticulum due to the accumulation of the fermentation gases, has been one of the most studied aspects of ruminant production. This is because of its economic impact on animal agriculture and the complex nature of the disease. In spite of the large quantity of research done, the etiology of bloat remains unknown and several researchers have proposed different hypotheses to explain it. Any acceptable hypothesis must be shown to operate in the bloating animal and not in the nonbloater in the same pasture at the same time.

There has been considerable success in the prevention and or treatment of this condition, particularly in the case of acute frothy bloat resulting from the intake of certain legumes. Poloxalene,[1] a nonionic surfactant (polyoxypropylene polyoxyethylene block polymer), has been particularly effective in preventing acute bloat.

Prevention of bloat has permitted intensive utilization of legume pastures which are specially important in areas where pastures are an important source of feed for cattle. Several methods of administering poloxalene to cattle have been tried in an attempt to obtain an appropriate intake of the drug under grazing conditions. The supplementation of molasses-salt blocks containing 6.6% poloxalene results in good consumption, but requires careful management in the pasture. Poloxalene is also fed to cattle top dressed on grain or incorporated in grain supplements. This method of administration requires daily grain feeding. In the

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[1]Product of Smith Kline and French Laboratories, Philadelphia, Pa.

research presented here, poloxalene was provided in liquid molasses supplements, in an attempt to simplify management in the field and secure a more regular intake of the drug. The use of liquid supplements in cattle feeding as a means of stimulating energy intake as well as serving as a carrier for nonprotein sources of nitrogen is popular in the United States.

Cattle have a liking for molasses and consume it to such an extent that it is necessary to restrict its consumption. The experiments were conducted to:

1) Study the intake of liquid supplements containing molasses when offered to cattle for a long period of time.
2) Study the feasibility of adding poloxalene to liquid supplements for cattle grazing legume pastures.
3) Formulate liquid supplements containing poloxalene to have the following characteristics:
    a) Provide a low but regular intake to secure the ingestion of an appropriate amount of poloxalene.
    b) Prevent acute bloat in cattle permitted to graze 24 hr daily.
    c) Provide a homogeneous liquid mixture of such stability that its components will not precipitate out in liquid supplement feeders.

REVIEW OF LITERATURE

Cause of legume bloat

Comprehensive reviews about bloat in ruminants have been published by Cole et al. (1945), Dougherty (1953), Cole et al. (1956), Johns (1958), Cole and Boda (1960), Grosskopf (1964), Hungate (1966) and Church (1968 a, b). Considerable progress has been achieved towards the understanding of the etiology of bloat, its prevention and treatment. The conditioning and causative factors that can be related in one way or another and the multiple interrelationships between them, makes it almost impossible to explain why bloat develops in all cases.

It is generally recognized that the frothing of digesta in the ruminoreticulum (Cole and Boda, 1960) will provoke acute frothy bloat. The other form of bloat, free gas bloat (Hungate, 1966) or chronic bloat (Cole et al., 1945) is also classified as secondary ruminal tympany by Blood and Henderson (1962), and it is due to the accumulation of fermentation gases which the animal is unable to eructate from the ruminoreticulum because of physical obstructions of the lower part of the esophagus due to injuries or abnormal growth in the cardial area or of the mediastinal lymph glands (Blood and Henderson, 1962). In frothy bloat, the fermentation gases are trapped in the form of a stable foam and when gas formation exceeds gas elimination, bloat occurs.

Several factors can be related to the presentation of legume bloat. Bartley (1965 a) classified them in three groups: plant, animal and microbial factors. Other factors such as weather have also been considered (Cole et al., 1945) but there is no reliable information on its influence in the development of the disease.

Plant factors. Grasses and certain legumes such as birdsfoot trefoil very seldom produce bloat. Other legumes such as alfalfa and clover have a very high bloat provoking potential especially when they are in a lush stage of growth. Bartley (1965 a) reported a decrease in bloat incidence with increasing maturity and decreasing protein content of alfalfa plants. Plants supply the substrate which will be fermented in the ruminoreticulum, supply foaming and antifoaming agents, and even can contribute toxic compounds (Johns, 1958). It is well known that gas under bloating conditions is not produced in abnormal amounts (Cole et al., 1945) but a rapid production of gas when the foaming conditions are present in the ruminal content can explain the rapid bloating of cattle when they are turned on an alfalfa pasture.

Analyses of bloat foams indicate that the foaming constituent is protein in nature (Bartley and Bassette, 1961). A relationship has been found between foaming potential and soluble protein content of alfalfa (Synhorst et al., 1963). Alfalfa juice extract tested in vitro for foaming potential suggested that the foaming properties may be inherited (Rumbaugh, 1969).

McArthur and Miltimore (1964) isolated a soluble protein from alfalfa leaves with a sedimentation constant of 18S. This compound stabilizes foam in the rumen. Further studies indicated that bloating forages contain approximately one-third of the total protein in the form of 18S protein, whereas nonbloating forages contain less than one-sixth as much (McArthur and Miltimore, 1969). This protein is presumed to be derived from the chloroplasts in plant cells. Saponin, a strong foam stabilizing agent in vitro, is found in larger amounts in legumes than in grasses (Church, 1968 b). However, conditions required for the foaming of saponins may not exist in ruminal contents during bloat (Bartley, 1967). The contribution of pectic substances present in the plant to the formation of foam (Conrad et al., 1958) has also been studied. In vitro tests conducted by Gupta and Nichols (1962) showed that pectic acid was formed when pectin methylesterase was added to a solution of pectin, bicarbonate and calcium or to a solution of ruminal fluid, pectin and calcium. Small bubbles of CO_2 were trapped in the gel formed. They reported that this enzyme system is present in fresh growing alfalfa and that certain microorganisms can adapt to its production. The plant also contributes antifoaming agents. Morgan et al. (1959) reported that chloroplastic lipids are effective antifoaming agents. Tannins present in certain legumes (birdsfoot trefoil and Onobrychis sativa) prevent bloat by precipitation in situ of chloroplastic and cytoplasmic proteins when limiting membranes are disrupted during mastication. Tannins also inhibit pectin methylesterase, slowing down pectin hydrolysis and its release of CO_2 and also minimizing the effect of pectins as a foam stabilizer (Vetter, 1969).

Animal factors. Some animals may bloat more readily than others because of differences in rate of flow of saliva, in rate of passage of materials through the ruminoreticulum or in rate of exchange between the rumen and the blood (Cole and Boda, 1960). Knapp et al. (1943) reported that the progeny of certain beef bulls were more susceptible to bloat than others. Work done with identical twins indicates that there is a great difference in bloat susceptibility between sets of twins but the difference is small within sets (Bartley, 1965 a). The large variability observed among animals in voluntary intake under grazing conditions (Marten, 1969) may also help explain the individual susceptibility to bloat. The role of saliva in the prevention of frothy bloat has been studied. The composition of saliva varies, depending on the relative contributions of the various salivary glands and the method of collection (Cole and Boda, 1960). By electrophoretic pattern determination of submaxillary mucoproteins, differences between animals were found. These may be inherited. Johns (1958) suggested that a large secretion of saliva could prevent bloat by buffering a fall in pH or increase its severity by adding to the CO_2 evolved and by assisting in foam formation because the mucoproteins can promote the formation of stable foam.

Mendel and Boda (1961) reported that nonbloaters secrete more saliva than bloaters. This was corroborated by Bartley (1965 a) working with identical twins. Van Horn and Bartley (1961) demonstrated that mucin in saliva is an effective antifrothing agent in vitro and Bartley and Yadava (1961) found that mucin also is a foam-inhibiting and foam-breaking agent in vivo.

Meyer et al. (1964) demonstrated that salivation decreased when the water content of the feed ingested increased, and salivation was greater in animals fed hay than in those fed fresh alfalfa. However, the large day to day variation attributed to the water content of feed masked a possible relationship between salivation and susceptibility to bloat.

Bartley (1967) reported that the decreased salivary secretion observed during grazing of lush legume pastures would allow the foam promoting agents of the plants to develop foam, whereas foam would not develop with mature pasture or hay because of the larger secretion of saliva. Immature grasses may induce frothy bloat because of their high nitrogen content which is much lower in mature grasses. Recently Clarke and Reid (1969) reported the production of strong foam when mucous saliva obtained from an esophageal fistula was incubated in vitro in concentrations up to 30% with rumen contents and a substrate of minced red clover. They also did not find a difference in saliva secretion between two cows with a high susceptibility to bloat and two others with a low susceptibility. It is probable that the conditions and methods utilized were completely different to the ones used in Kansas.

Another important animal factor that should be considered is the eructation mechanism. It has been demonstrated that the cardia must be cleared of digesta in order for eructation to take place. Dougherty et al. (1965) concluded that eructation is a different mechanism than the regurgitation phase of the rumination reflex because:

a) The speed of the esophageal "reverse peristalsis" is greater than any other motor event involving this structure,

b) The glottis remains open during the active phase of eructation,

c) The eructation inhibitory reflex is initiated by stimulation of inhibitory receptors around the cardia when these are covered with ingesta, foam and other non volatile materials (normally only gas is eructated), and

d) The eructation reflex is stimulated by gaseous distention of the ruminoreticulum and not by the irritation of the walls by scabrous material in the feed.

Microbial factors. The role of ruminal microorganisms in bloat is not clear. Using identical twins, Bartley et al. (1961) showed that cows deprived of rumen microorganisms (the rumens were emptied and washed; autoclaved strained rumen fluid obtained from bloating animals was added) had a normal intake of alfalfa pasture by the third day and bloated by the fourth day, whereas cows inoculated with fresh strained rumen fluid, bloated the second day. They also reported that inocula of bloated animals digested filter paper in vitro more slowly than did inocula from nonbloated animals. Kodras (1966) reported the presence of gas-bubble-producing protozoa in samples obtained from the rumens of cattle fed feedlot rations. The species that showed this phenomena were Ophryoscolex and the largest amount of them was found in samples collected two hours after feeding. This phenomena was seldom observed in control animals.

Clarke (1965) reported that the holotrich protozoa were reduced in numbers in samples obtained from bloated animals. A strong correlation between the content of storage polysaccharide in these ciliates before feeding and the severity of the bloat that followed, was obtained. The reduction in number was explained by the bursting of these protozoa. The cell content of these protozoa, particularly the nucleic acids, was found to have strong foam-stabilizing properties. McArthur and Miltimore (1969) found no significant differences between the nucleic acid contents of bloating and nonbloating forages. It seems that an increase of the ruminal content of nucleic acid in the bloated animal would not be due necessarily to the intake of forage. Clarke et al. (1969) tried to prevent bloat utilizing an antiprotozoal compound called dimetridazole (1, 2-dimethyl-5-nitroimidazole) which also had some effect on rumen bacteria. Bloat was reduced in the treated cows but also feed intake and rumen fermentation were depressed. Bloat was present even when the holotrich protozoa had been eliminated from the rumen.

The control of legume bloat, obtained by administration of penicillin and other antibiotics, suggests some microbial factor is needed for the production of frothy bloat. Snyder (1964) found that penicillin treated animals had decreased concentrations of rumen ammonia nitrogen, blood ammonia nitrogen and hydrogen ions, in relation to the bloated control animals. The color of the rumen content was darker in the treated animals and the authors suggested that the antibiotic reduced the rate of degradation of the alfalfa tops fed.

Hungate et al. (1955) observed that certain strains of nonspore-forming butyric acid-producing rods, isolated from cattle grazing ladino clover, produced foam under specific culture conditions and suggested that slime produced by bacteria in the rumen may be associated with the formation of stable foam in legume bloat. They also reported that the rumen fermentation products in bloating and nonbloating animals on a ladino clover pasture were identical in the percentage of acids, CO_2 and CH_4, even though the total quantities were different.

Bryant et al. (1960) found no difference in slime or butyrivibrio strains in samples obtained from bloated and nonbloated animals.

Fina et al. (1961) reported that salivary mucin can be broken down by the mucinolytic activity of ruminal bacteria, thus reducing the concentration of this natural antifoaming agent in the rumen. When cultures of these strains were inoculated into the rumen of animals consuming nonbloating alfalfa pasture, bloat was developed. Further work done at Kansas State University revealed mucinolytic activity in several strains of aerobic and anaerobic bacteria isolated from the rumen (Mishra et al., 1967; Mishra et al., 1968). Bartley (1965 a) suggested that antibiotics may prevent bloat by destroying mucinolytic bacteria, slowing down gas production and by inhibiting bacterial processes involved in forming rumen foam.

Prevention of legume bloat

The number of factors suggested as causing or predisposing to legume bloat, and probably other factors still unknown, makes its prevention and treatment difficult.

Several procedures and drugs have been suggested for these purposes. Some of them are effective, some are not, and others are effective only for a short period of time. Since the most important aspect of legume bloat is the frothing of the ruminal digesta, most of the research done on the prevention of legume bloat during the last years has pertained to the use of surface active agents.

Management practices. Legume bloat can be avoided by not allowing ruminants to eat fresh bloat provoking legumes. This practice is undesirable because of the high nutritive value of legumes, their stimulatory effect on milk production (Stiles et al., 1968) and their soil-building properties.

Legume bloat has been provoked by grazing certain lush legumes, soilage or even hay (Crenshaw, 1967).

Essig et al. (1964) reported no incidence of bloat when cattle grazed three varieties of clover, lespedeza or alfalfa in the full bloom stage, whereas during the pre-bloom stage of growth the incidence and severity of bloat was high. They concluded that the crude fiber content of the plant was correlated with the incidence of bloat.

Bartley (1967) stated that "... in general, any plant constituent that decreases with increased plant maturity correlates well with the incidence of bloat and any constituent whose content increases with maturity, correlates well with the apparent absence of bloat ...". Rivadeneira and Davidovich (1970) reported bloat in steers grazing mature alfalfa pastures

(33 to 53 day periods between grazing to obtain the desired maturity). Bloat occurred during the first few days of grazing each pasture plot probably because the animals ate the tops.

Colvin et al. (1958) reported that feeding 5.5 kg of oat hay of excellent quality overnight to dry cows reduced significantly the incidence and severity of acute bloat when the cattle were permitted to graze an immature alfalfa pasture. Rivadeneira and Davidovich (1970) fed 3.55 kg of oat hay to steers (average weight 186 kg) 2 hr before the morning grazing without a significant effect on bloat and body weight gains.

Cole et al. (1956) discussed other management practices such as offering legume soilage instead of pasture strip grazing. Pastures with up to 50% legumes are relatively safe, but palatability of the grasses in relation to the legume is an important factor to be considered.

Mixed pastures of grasses and legumes are difficult to maintain because of the different requirements of the plants. In irrigated pastures under some conditions, grasses tend to grow better than legumes. Frequency and intensity of grazing are usually different for grasses than for legumes. Blaser et al. (1969) reported that "... it is more difficult to maintain clover with tall fescue than with the other grasses. Fescue is aggressively competitive because it grows in drier, cooler and warmer environments than clover. Because of low palatability and therefore less grazing, the dense fescue sod inhibits clover stands." The same may happen with other mixtures. In general, any kind of management practice which will reduce the production of lush legume will increase feed of inferior nutritive value.

Use of drugs and antifoaming agents.

Barrentine et al. (1956) presented the first report on control of legume bloat with antibiotics administered orally to cattle. Procaine penicillin given orally at the rate of 50-75 mg per head per day was effective for one to three days.

Essig (1967) reviewed the use of antibiotics for the control of bloat. Jacobson (1967) concluded that antibiotics would prevent bloat for a period of 1 to 2 wk after which time the normal bloating pattern was quickly resumed. Since the most effective antibiotics are neither approved nor available for use, it was further concluded that antibiotics do not currently offer a satisfactory means of control over extended periods.

An extensive number of antifoaming agents of various kinds have been used successfully for the control or prevention of legume bloat. The main effect of these substances is to reduce the surface tension of rumen contents since the surface tension of rumen fluid under bloat conditions is usually higher than when bloat is absent. Oils (animal, vegetable and mineral), long chain alcohols, fatty acids and various detergents have this property (Jacobson, 1967). These substances seem to disappear quite rapidly from the ruminal digesta, and therefore are only effective for a few hours for bloat control (Snyder, 1964). A dilution of silicone in paraffin oil was found effective by Johns (1954) probably because of the action of paraffin oil, since further investigation by Reid and Johns (1957) failed to demonstrate its protective effect.

Reid and Johns (1957) found that bloat can be prevented in cows grazing clover pastures with the use of vegetable oils, turpentine, emulsified tallow, whale oil, cream, lanolin, five grades of liquid paraffin and paraffin wax emulsions. Vegetable and mineral oils have been widely used in New Zealand and Australia.

Oils and tallows are usually used for pasture spraying before the animals start grazing. Oils are now preferred because they are cheaper, easier to handle and of reliable quality. Under average conditions, oil emulsions in water are applied at a rate of about 90 ml of oil per cow per day. Besides the cost of the oil, the procedure requires a tractor, spraying equipment, electric fences and labor. A cheaper procedure is misting the pasture with a nonemulsifying type of oil. When oil is administered by drench, the protection obtained is only for 2 to 4 hours. Another method of administration is to paint the flanks with a highly viscous oil where the animals will lick it periodically. However, with this method failures are frequent (Wolfe and Sjostedt, 1970).

Gupta and Nichols (1962) demonstrated in vitro the action of alkylaryl sulfonate in inhibiting the activity of pectin methylesterase which under certain conditions acts on pectin and forms a gel that can trap CO_2 bubbles and yield a stable foam.

Nichols (1963) reported a 96% reduction in the incidence of experimental bloat when the animals were supplemented with alkylaryl sulfonate prepared for controlled release in the rumen. Poloxalene, a nonionic surfactant, first described by Bartley (1965 b) has been demonstrated to be a reliable drug in the control of legume bloat. Chemically it is a polyoxypropylene polyoxyethylene block polymer. This report demonstrated that the supplementation of 5 to 10 or 20 g poloxalene via a rumen fistula or as a top dressing in grain was effective in controlling bloat for 12 hours in bloat susceptible cows consuming fresh alfalfa. Meyer et al. (1965) reported that poloxalene is poorly absorbed from the digestive tract, is not deposited in body tissues and does not appear in milk.

In further trials at Kansas State University, poloxalene did not affect milk production, milk fat test, body weight, feed consumption, conception rate, animal health or rumen fermentation (Helmer et al., 1965).

Lippke et al. (1970) found no significant detrimental effect on young Holstein calves fed 1 and 4 g poloxalene per 45 kg body weight administered daily for a period of 140 days.

Poloxalene can be provided to susceptible animals in many different ways. Each form has advantages and disadvantages and the choice of a particular form will depend on the conditions under which the animals are maintained.

Essig et al. (1966) found that molasses blocks containing 66 g of poloxalene per kg provided an adequate intake of the surfactant with the advantage that the animals licked the blocks by themselves and there was no need to supplement the animals individually. Stiles et al. (1967) reported that the intake of the poloxalene blocks varied between 0.23 to 0.44 kg daily per animal and was independent of body weight. Weather and management factors seemed to affect the intake of blocks by the animals. Even with these variabilities in the ingestion of the surfactant, severe bloat was prevented when the animals grazed alfalfa pasture or were fed fresh cut alfalfa.

Another way to provide poloxalene is in the form of a top dressing in grain. Stiles et al. (1968) provided 20 g poloxalene daily in the grain ration to 10 milking cows grazing alfalfa pastures for 8 weeks. Only three cases of mild bloat were reported. Poloxalene can be used also as a treatment of frothy legume bloat. Bartley et al. (1967) found that bloat was effectively treated when 25-50 g of poloxalene was administered by drench in 0.5 liters of water or by stomach tube but the intraruminal injection of 50 to 100 g was not satisfactory.

Liquid molasses supplements for cattle

According to Curtin (1968): "Molasses has been recognized for many years as an excellent feed for livestock and has been used as a carrier for other feed additives since before 1900. Palatability, excellent nutritional characteristics, good keeping qualities, ease of distribution and widespread availability at low cost have made molasses an accepted feed ingredient throughout the world." The cost of molasses will vary considerably according to the distance between the point of production and the point of delivery. Special equipment is needed for proper handling and storage. The nutritional value is related to its high content of sugars and nitrogen-free extract.

The estimated use of inedible molasses in feeds in 1969 was 3,350 million tons for the United States (Schoeff, 1970): this amount includes cane molasses, refiners molasses, beet molasses, citrus molasses, corn sugar molasses, hemicellulose extract and grain sorghum molasses. Blackstrap molasses is obtained from the sugar cane refining process, without dilution, whereas cane molasses is diluted with water to a standard of 79.5° Brix as defined by the Association of the American Feed Control Officials. It requires about 138 gallons of water to dilute 1000 gallons of 89° Brix blackstrap to produce the refined cane molasses (Wornick 1969).

Blackstrap and cane molasses account for 70 to 80% of the total available supply of industrial molasses in the US (Curtin 1968). There are physical and chemical differences between the various kinds of molasses. Since they are byproducts, considerable variation can be expected in color, flavor, viscosity, sugar content and specific gravity. This occurs even in molasses having the same origin and meeting trade standards (Curtin 1968). These differences and the composition of the nonmolasses portion of the ration, as suggested by Martin and Wing (1966), may explain in part the discrepancies observed in the results of trials utilizing molasses as a source of energy for ruminants.

Molasses is used in concentrate mixtures to provide energy, enhance the acceptability of the feed and reduce dust during processing and feeding. Also molasses is used in a liquid form as a carrier of non protein nitrogen, minerals, antibiotics and other nutrients.

The effect of the level of molasses on feed utilization has been controversial since 1907. Wing and Powell (1969) cited Patterson and Outwater who observed increased digestibility of cattle rations when 25% molasses was included in the ration and Lindsay, Holland and Smith who observed depressed digestibility when 20% of the ration dry matter was molasses. Since then numerous trials have been reported with conflicting results. Some of these trials will be considered.

Brannon et al. (1954) determined during 139 days of experimentation with year old beef steers that the feeding of 2.27 kg of molasses per day to animals grazing a mixed pasture composed of one-third legumes and two-third grasses, markedly depressed the digestibility of dry matter but produced better gains than in the nonsupplemented group.

Klosterman et al. (1956) reported that cane molasses seemed to have some sparing effect on the protein requirements when the animals consumed a ration with a sub-optimal level of protein. When a markedly deficient protein ration was fed, this effect was not present. They concluded that the effect was the result of increased feed consumption and not the result of improved feed utilization.

Bohman et al. (1954) found that the feeding of 2.27 kg daily of a molasses-urea mixture to growing dairy cattle consuming timothy hay, reduced the digestibility coefficients of dry matter, organic matter, ether extract and crude fiber. When good quality legume hay replaced timothy hay, excellent gains were obtained. They concluded that satisfactory gains can be obtained with molasses when sufficient or excess protein is supplied by the hay.

Lofgreen and Otagaki (1960 a, 1960 b) reported that supplementing rations with more than 10% blackstrap molasses had a detrimental effect on milk production and weight gains in dairy cows and steers, respectively. Preston et al. (1969) recalculated the data presented by Lofgreen and Otagaki (1960 b) and with the support of research done by themselves claimed that there is no decrease in efficiency when molasses is increased even up to 71% of the ration.

Martin and Wing (1966) fed four levels of molasses (0, 6, 12, and 18%) with a high concentrate ration to dairy steers and found no difference in the digestibility of dry matter, cellulose and energy, and in the production of isovaleric acid among the molasses containing rations. Significant differences in these parameters were obtained between the molasses supplemented groups and the control animals. Rumen pH, digestibility of crude protein, the rate of production of acetic, propionic, butyric and valeric acids were not different among rations. Wing and Powell (1969) using the same basal ration, included 4.2 and 12.6% cane molasses in the total ration of lactating dairy cows and found no difference between the levels of molasses supplementation, but the supplemented cows produced significantly less milk, less milk fat and solids nonfat than did the control animals.

Recently, considerable attention has been given to the use of liquid feed supplements for cattle. They usually contain an appreciable amount of liquid molasses and are used as a carrier for nonprotein nitrogen. Beeson (1969) has postulated that liquid protein supplements for beef cattle have finally been developed to the point of being equal to dry protein supplements if they are formulated to contain the same essential nutrients. Because "...cattle do not distinguish between the same nutrients fed in a dry or liquid form. There is no nutritional advantage in liquid supplements or liquid feeds, it is just another way to balance the ration for growing, finishing and maintaining of cattle."

Alexander (1971) agreed with Beeson (1969) that for high energy finishing rations, dry and liquid supplements are similar. There is a slight advantage in feed efficiency for the dry forms which is contrasted with a lower cost of production for the liquid forms. Liquid supplements have advantages of easier management and handling and provide a more homogeneous mixture of nutrients.

Brinegar (1971) claimed that dry supplements provide a faster gain and better utilization than liquid supplements, resulting in more profit.

It is necessary to point out that the "sugars of molasses do not favor as efficient a conversion of urea nitrogen to protein as does starch" (Loosli and McDonald, 1968).

EXPERIMENTAL PROCEDURE AND RESULTS

Five experiments were conducted to study the consumption of liquid molasses supplements with and without poloxalene. The first three experiments were with steers pastured on alfalfa or fed alfalfa hay in drylot. Experiment 4 was conducted with steers and heifers pastured on alfalfa and Experiment 5 was with heifers pastured on alfalfa. The objective of the experiments was to formulate a liquid supplement with poloxalene that would provide a minimal intake of molasses in order to reduce costs and permit a constant intake of poloxalene in amounts needed to control legume bloat under practical conditions of grazing.

Since the effectiveness of poloxalene in the prevention of legume bloat has been demonstrated elsewhere, it was assumed that the appearance of bloat during the poloxalene supplemented trials would reflect an insufficient intake of the supplement. Bloat was graded using the 0 to 5 scale described by Johnson et al. (1958).

Wheel type liquid supplement feeders were used. Each feeder was 86 cm x 86 cm x 55 cm and had two wheels. The animals ingested the supplements by licking the wheels. Each group had access to one feeder and the intake of the liquid supplements was measured volumetrically at 8 a.m. daily.

In experiments 1, 2, 3 and 4 (trials 1 to 14) eighteen mature steers with body weights ranging from 678 to 1011 kg were divided into two groups of 9 each. The average weight was 787 kg for group 1 and 800 kg for group 2. The steers had never grazed before these experiments and were selected because of their susceptibility to bloat in feedlot trials.

In experiments 4 and 5 (trials 15, 16 and 17) seventeen growing heifers weighing from 245 to 472 kg constituted groups 3 and 4. Group 3 had 8 heifers with an average weight of 371 kg and group 4 had 9 heifers with an average weight of 357 kg. In trial 18 of experiment 5 three more heifers were added and the average weight for the group was 415 kg (258 kg to 555 kg).

An alfalfa pasture, variety Buffalo, in its third year of production was divided in two plots, each with an area of 3.5 ha. A portable electric fence was used to subdivide each plot. Every 2 to 4 days the portable fence was moved and new pasture was available for grazing. Fresh water was available at all times.

During the feedlot trials each group received approximately 180 kg alfalfa hay (medium quality) once a day.

Experiment 1

Experimental procedure.

This experiment was designed to study the effectiveness of the addition of 2.2% poloxalene to cane molasses or to a solution of molasses, water and salt.

Preliminary period. (September 26 to October 1, 1969). The purpose of the preliminary period was to permit the cattle to become accustomed to the pasture. No liquid supplement was offered. Two groups of steers (9 per group), one group per pasture plot, were allowed to graze from 7:30 to 10:30 a.m. and from 2:30 to 5:30 p.m. During the period when not grazing each group was confined in separate pens located adjacent to the pasture. Fresh water was available in the drylot.

Trial 1. (October 2 to 6, 1969). At the end of the preliminary period, a liquid supplement feeder was placed in each of the two pasture plots and both groups of cattle were offered cane molasses supplemented with 2.2% of poloxalene (22 g/kg). The purpose of the trial was to determine the daily intake of the molasses supplement containing poloxalene.

Trial 2. (October 7 to 13, 1969). The purpose of this trial was to determine if the liquid supplement intake could be reduced by adding salt. Water was added to keep the salt in solution. Group 1 received a liquid supplement containing 45.7% cane molasses, 40.0% water and 14.3% salt whereas group 2 had access to a mixture of 44.7% molasses, 39.2% water, 14.0% salt and 2.1% poloxalene.

Trial 3. (October 14 to 21, 1969). The purpose of this trial was to determine the effect on intake of the addition of poloxalene to molasses. Group 1 received cane molasses alone whereas group 2 received cane molasses with poloxalene as in trial 1.

Results and discussion.

The incidence of bloat is shown in table 1. During the preliminary period some bloat was observed in both groups. During trial 1 both groups received poloxalene and the incidence of bloat was reduced. In trials 2 and 3 the incidence of bloat increased in group 1 receiving no poloxalene and remained absent in group 2 receiving poloxalene.

During trial 1 the liquid supplement intake differed greatly between the two groups of steers even though the supplements were identical. The addition of salt and water to the supplement (trial 2) reduced the intake for group 2 steers. The intake of the animals in group 1 increased. Since these animals in trial 2 received a supplement containing salt but no poloxalene it was not possible to determine whether the increase was due to the removal of poloxalene. Consequently trial 3 was conducted where group 1 animals received the supplement used in trial 1 without poloxalene and group

Table 1

Incidence of bloat (Experiment 1).

	Preliminary			Trial 1			Trial 2			Trial 3		
	Bloat score[a]			Bloat score			Bloat score			Bloat score		
	1	2	Total	1	2	Total	1	2	Total	1	2	Total
Group 1	10	5	15	2	0	2	14	4	18	15	1	16
Group 2	3	1	4	0	0	0	0	0	0	0	0	0

[a]Number of cases with a bloat score of 1 or 2. No higher scores were observed.

2 received the trial 1 supplement with poloxalene. Since both groups increased in intake during trial 3 over trial 2 it may be concluded that the addition of salt to the supplement depressed intake. Apparently the addition of poloxalene without salt to the supplement depressed intake only slightly if at all.

During the 20 days that experiment 1 was conducted the animals ingested the supplements every day. However group 2 animals had very low average intakes on two days. On the fourth day of trial 2 the average intake per head for group 2 was 0.63 kg of supplement which provided only 1.68 g of poloxalene per 100 kg of body weight and on the third day of trial 3 the average consumption for group 2 was 0.36 kg per head which provided 1.00 g of poloxalene per 100 kg body weight. In both cases no bloat occurred in steers in group 2 but group 1 steers had three cases of bloat on both days. Apparently the intake of liquid supplements containing poloxalene were large enough to prevent bloat.

Table 2

Average liquid supplement consumption per head per day (Experiment 1)

Trial	Treatment	Group	Liquid supplement intake		Poloxalene intake	
			(kg)	(kg/100 kg wt)	(g)	(g/100 kg wt)
1	Molasses	1	1.54(0.26)[a]	0.196(0.033)	33.80(5.74)	4.31(0.73)
	Molasses	2	3.82(0.96)	0.479(0.121)	84.20(21.29)	10.55(2.67)
2	Molasses + salt	1	2.08(0.30)	0.265(0.037)	------------	----------
	Molasses + salt	2	1.99(0.53)	0.249(0.066)	41.99(11.06)	5.26(1.39)
3	Molasses	1	2.86(0.20)	0.364(0.025)	------------	----------
	Molasses	2	3.03(0.76)	0.379(0.095)	66.75(16.76)	8.36(2.10)

[a]Values in parenthesis are standard errors of the mean.

The liquid supplements of trial 2 produced a slimy precipitate on the feeders.

During the last three days of trial 3, there was a shortage of pasture which resulted in an increased intake of the liquid supplements.

Experiment 2

Experimental procedure.

Experiment 2 was conducted during the winter (November 19, 1969 to March 3, 1970) with the two groups of steers used in Experiment 1. The steers were maintained in two separate pens in drylot with fresh water available at all times. A wooden liquid supplement feeder was placed in each pen.

Since freezing temperatures were expected to occur, preliminary stability determinations of the supplements were made in the laboratory with respect to the physical state of mixtures containing cane molasses and water. Salt was added to decrease the freezing point and to regulate the intake of the supplements.

All the mixtures prepared in the laboratory were stored in a freezer at -29 C followed by incubation at 40 C. Bacteriological cultures were made of some of the mixtures. Agar plates and liquid thiocolate were inoculated with the supplements to estimate the degree of contamination. Once the experimental solutions were thoroughly mixed, they were covered with aluminum foil to reduce dehydration.

Laboratory trials.

Trial L 1. Duplicate solutions containing molasses, water and salt in the concentration of 40:50:10; 30:50:20 and 20:60:20 were prepared. The ingredients were measured by weight to a final weight of 500 g for each solution. After the solutions were prepared they were stored in a freezer for 7 days. The solutions containing 10% salt were the only ones that froze. When removed from the freezer the solutions were incubated at 40 C. A similar amount of molasses alone and a solution containing 25% molasses and 75% water were incubated and served as controls. After 4 days of incubation the samples containing molasses and water were the only ones that exhibited microbial growth. It was in the form of a clear blue supernatant.

Trial L 2. Mixtures of cane molasses, water and salt in the proportions of 30:55:15; 25:60:15; 20:60:20 and 20:65:15 were prepared as in trial L 1 and stored in the freezer for 7 days. The mixtures containing 20% molasses with 15% salt froze. All the samples had a light sediment which was roughly proportional to the amount of molasses utilized. After removing the mixtures from the freezer they were stored in an incubator at 40 C for 4 days. No microbial growth was apparent after incubation.

Trial L 3. Mixtures of cane molasses, salt and water with and without 1% poloxalene were prepared as in trial L 1, but to a total amount of 100 g each. The concentrations studied were: 30:55:15; 25:60:15; 20:60:20 and 20:65:15 of cane molasses, water and salt respectively. Controls consisted of molasses only and a mixture of 25% molasses and 75% water, both with and without poloxalene. After 18 days of storage in the freezer the only samples that froze were the mixtures of 20:65:15 and 25:75:0 with and without poloxalene. Immediately after they were removed from the freezer the samples were kept in an incubator for 10 days. After incubation a slimy precipitate was observed in the solutions containing salt. The control sample containing molasses and water only had a light blue supernatant formed by a bacillus gram positive organism. Thiocolate and agar plates were inoculated with all samples. After 4 days of incubation, the samples with no salt showed high turbidity in the thiocolate media. No bacterial growth was evident in the agar plates.

Drylot trials.

Trial 4. (November 19-24, 1969). Both groups of steers received a liquid supplement containing 50% cane molasses and 50% water.

The results of trial 2 indicated that the dilution of cane molasses in approximately the same weight of water and the addition of 14% of salt reduced considerably the daily intake of the liquid supplement and hence, of the molasses. Loosli and McDonald (1968) suggested that the dilution of molasses with water would increase the intake of the molasses when compared with feeding molasses alone.

Trial 5. (November 25-December 1, 1969). Both groups received a liquid supplement containing 30% cane molasses, 50% water and 20% salt.

Trial 6. (December 2-8, 1969). Both groups received a liquid supplement containing 30% molasses, 55% water and 15% salt.

Trial 7. (December 9-31, 1969). Group 1 had access to the supplement used in trial 5 and group 2 to the one used in trial 6.

Trial 8. (January 1-23, 1970). The same liquid supplements as used in trial 7 were used except that treatments and pens were switched.

Trial 9. (January 24-March 3, 1970). This trial was designed to study the effect of the consumption for an extended period of time (39 days) of the liquid supplements studied in trial 8.

Results and discussion.

Table 3 contains data on the average consumption of the supplements.

Table 3

Average liquid supplement consumption per head per day (Experiment 2)

Trial	Treatment	Group 1 Liquid supplement intake		Treatment	Group 2 Liquid supplement intake	
	(%)	(kg)	(kg/100 kg wt)	(%)	(kg)	(kg/100 kg wt)
4	Water 50	11.29(1.86)[a]	1.436(0.239)	Water 50	11.33(1.84)	1.420(0.230)
5	Salt 20	2.18(0.29)	0.277(0.037)	Salt 20	2.49(0.48)	0.312(0.060)
6	Salt 15	2.45(0.22)	0.312(0.030)	Salt 15	3.63(0.40)	0.455(0.050)
7	Salt 20	2.26(0.33)	0.288(0.042)	Salt 15	1.49(0.23)	0.187(0.029)
8	Salt 15	0.62(0.10)	0.079(0.020)	Salt 20	0.99(0.20)	0.124(0.025)
9	Salt 15	1.13(0.11)	0.144(0.014)	Salt 20	1.31(0.13)	0.164(0.017)

[a]Values in parenthesis are standard errors of the mean.

A mixture of cane molasses and water (trial 4) resulted in an extremely high intake of the liquid supplement with a very irregular day to day consumption as estimated by the standard error.

During 210 group days of the experiment there were only 15 group days when there was no intake of the supplement (Table 4).

The solutions containing 15% salt and 55% water were consumed in larger amounts than the liquid supplements containing 20% salt and 50% water. During trials 8 and 9 the smallest intake occurred probably because of cold weather during this period. During trials 8 and 9 the coldest temperatures (-23 C) and the largest precipitation of snow occurred.

All the supplements containing salt and water developed a slimy precipitate in the feeders. The precipitate was removed approximately each week. The supplements did not freeze during the coldest weather (-23 C). Since all the supplements precipitated in the feeders, no further attempt was made to study the intake of these supplements under grazing conditions.

Table 4

Number of days with no intake of liquid supplement

Trial	Group 1	Group 2
	Days	Days
7	1	5
8	3	2
9	2	2
Total	6	9

Experiment 3

This experiment was designed to study another approach to reduce the intake of the liquid supplements. Supplements containing hemicellulose extract[2] (wood molasses), were compared with those containing cane molasses. The same two groups of animals were used.

Experimental procedure.

Trial 10. (March 4 to 9, 1970). This trial was conducted in drylot for 5 days with group 1 and 6 days with group 2. Group 1 was offered a liquid supplement containing 35% cane molasses, 52% water, 10% salt and 3% phosphoric acid (75% concentration). Group 2 received a similar supplement but with hemicellulose extract replacing cane molasses.

Trial 11. (May 6-18, 1970). The same pasture utilized for Experiment 1 was grazed by the two groups of steers. A liquid supplement containing 59% hemicellulose extract, 30% water, 7% salt, 3% phosphoric acid (75% concentration) and 1% concentrated sulfuric acid was offered to group 1, whereas group 2 received the same formulation but with cane molasses instead of hemicellulose extract. The first four days were considered as a preliminary period to get the animals accustomed to the pasture and to check the bloat potential of the pasture. The animals were managed as in Experiment 1.

On the fifth day (May 10), poloxalene was added to the feeders at a level of 22 g per kg of liquid supplement. The pasture was actively growing and lush. Strip grazing was practiced with the steers receiving new pasture approximately every other day. Two days after the poloxalene was added to

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[2]Product of the Masonite Corporation, with the trade name of Masonex, courtesy of Dale F. Galloway.

the liquid supplements the steers were allowed to graze 24 hr. a day. Each day they were checked several times for manifestations of bloat.

Trial 12. (May 19 to June 1, 1970). During the next two weeks following trial 11 (14 days group 1 and 13 days group 2) untreated molasses was offered to both groups. Group 1 had access to hemicellulose extract and group 2 to cane molasses. The animals were allowed to graze at will and bloat was recorded.

Results and discussion.

The results of trials 10, 11 and 12 (Table 5) show that hemicellulose extract alone or in mixtures with other ingredients resulted in smaller intakes when compared with cane molasses alone or in the same mixtures. Also, the day to day variation (shown by standard error of the mean) in intake was lower for the supplements containing hemicellulose extract than for those containing cane molasses.

Data on the incidence of bloat are presented in table 6. No bloat control occurred in trial 10 since it was conducted in drylot with animals consuming hay. During the preliminary period of trial 11 all animals bloated, thus demonstrating the bloating potential of the pasture. There was no bloat whatever during trial 11, when both groups of steers received supplements containing poloxalene. Apparently the intake of poloxalene through the supplement was sufficient in all animals to prevent bloat. This suggests that the animal to animal variation in supplement intake is minimal. Steers in group 1 started bloating on the afternoon of the second day after the poloxalene supplementation was discontinued.

Table 5

Average liquid supplement consumption
per head per day (Experiment 3)

Trial	Treatment	Group	Liquid supplement intake		Poloxalene intake	
			(kg)	(kg/100 kg wt)	(g)	(g/100 kg wt)
10	Cane[a]	1	3.67(0.63)[b]	0.468(0.081)	----------	----------
	HCE[c]	2	2.31(0.52)	0.290(0.065)	----------	----------
11	HCE	1	0.94(0.11)	0.119(0.014)	20.67(2.39)	2.63(0.30)
	Cane	2	1.52(0.23)	0.190(0.029)	33.44(5.00)	4.19(0.63)
12	HCE	1	2.91(0.37)	0.371(0.047)	----------	----------
	Cane	2	4.24(0.58)	0.544(0.074)	----------	----------

[a]The source of molasses was cane molasses.

[b]Values in parenthesis are standard errors of the mean.

[c]The source of molasses was hemicellulose extract.

Table 6

Incidence of bloat (Experiment 3)

Trial	Group	Treatment	No. cases with a bloat score of: 1	2	3	4	5	Total
Preliminary	1	HCE	12	7	3	1	0	23
	2	Cane	18	10	3	1	0	32
11	1	HCE+Poloxalene	0	0	0	0	0	0
	2	Cane+Poloxalene	0	0	0	0	0	0
12	1	HCE	20	8	4	0	0	32
	2	Cane	7	2	0	0	0	9

Experiment 4

Experiments 1, 2 and 3 demonstrated that a fairly large reduction in the intake of molasses could be obtained by adding salt to the supplement. In Experiment 2, levels of 15 and 20% salt provided a reduced and sustained intake of liquid supplements for 105 days. Since the inclusion of salt in the supplement resulted in a precipitate in the feeders, it was necessary to look for another method of reducing the intake of the molasses supplement. Commercial liquid supplements containing ammonium polyphosphate were tested in Experiments 4 and 5.

Experimental procedure.

Trial 13. (June 3 to 9, 1970). The two groups of steers were offered a commercial liquid supplement (Formula T) containing 22 g/kg of poloxalene for seven days. The composition of the supplement is shown in table 7. The fences were moved every day in order to offer both groups a lush bloat provocative pasture.

Table 7

Composition of liquid supplements[a] (Experiments 4 and 5)

	Formulas		
	T	U	V
	----------(% w/w)----------		
Poloxalene	2.220	1.650	1.650
Water	20.000	20.000	10.000
Vitamins A & D mixture	0.018	0.018	0.018
Trace mineral mixture	0.124	0.124	0.124
Ammonium polyphosphate (10-34-0)	2.660	2.660	2.660
Phosphoric acid (75% concentration)	3.370	3.370	3.370
Sulfuric acid	1.000	1.000	1.000
Molasses (cane)	70.628	71.176	81.187

[a]Supplements T, U and V were furnished by Smith Kline and French Laboratories, Philadelphia, Pa. and National Molasses Co., Willow Grove, Pa.

Trial 14. (June 19 to 25, 1970). This trial was a repetition of trial 13 with the difference being that the animals grazed an area located on an average of 380 m from the feeders instead of an average of 150 m as in trial 13.

In the period between trials 13 and 14 the two groups of steers received the liquid supplement without poloxalene and bloat scores were recorded. The intake of the liquid supplement was not obtained.

Trial 15. (June 26 to July 11, 1970). Seventeen heifers were allotted to two groups. Group 3 and 4 contained 8 and 9 animals respectively. Both groups grazed the alfalfa pasture used in the earlier experiments. The heifers were managed like the steers used previously. Since the heifers had not been allowed to graze before this trial nor had they had access to liquid supplements, they were confined to a reduced area of a mature section of the pasture with the liquid supplement feeders for 6 days before the starting of this trial. Both groups had access to the same liquid supplement consumed by the steers in trials 13 and 14.

Trial 16. (July 12 to 21, 1970). At the end of trial 15 the treatments of the two groups of heifers were switched. The grazing and management conditions were maintained as in trial 15.

Results and discussion.

The intake of liquid supplement in trial 13 was greater than that in trial 14 (Table 8) probably because the distance of the feeders from the pasture being grazed was more than twice that of trial 14. During the second day of trial 13 no liquid supplement was ingested by both groups and no bloat was observed.

On the 7th day of trial 16 both groups apparently did not consume the liquid supplement. Since it rained it is probable that enough rain water entered the feeder and masked the true intake of supplement.

The heifers demonstrated less variability in day to day intake of the liquid supplement (Table 8) than did the steers. Since bloat was not observed in any of the four trials, apparently the intake of poloxalene was sufficient to prevent it. During the period between trials 13 and 14 only one steer (group 2) did not bloat (Table 9). The incidence of bloat was lower in group 2 animals than those in group 1. Two cases of bloat with 5 scores required immediate treatment with an oral dose of poloxalene (40 g per steer). The steers recovered within an hour after treatment.

Table 8

Average liquid supplement consumption per head per day (Experiment 4)

Trial	Treatment Formula	Group	Liquid supplement intake		Poloxalene intake	
			(kg)	(kg/100 kg wt)	(g)	(g/100 kg wt)
13	T	1	2.72(0.65)[a]	0.346(0.083)	60.00(14.32)	7.64(1.82)
	T	2	3.32(0.79)	0.417(0.099)	73.00(17.34)	9.18(2.17)
14	T	1	1.98(0.14)	0.252(0.017)	43.71(3.23)	5.57(0.41)
	T	2	1.60(0.30)	0.201(0.011)	35.29(6.60)	4.42(0.83)
15	T	3	0.71(0.09)	0.193(0.026)	15.74(2.07)	4.25(0.18)
	T	4	0.42(0.07)	0.118(0.019)	9.26(1.48)	2.60(0.41)
16	T	3	0.71(0.11)	0.193(0.029)	15.74(2.36)	4.25(0.64)
	T	4	0.51(0.06)	0.144(0.018)	11.22(1.41)	3.15(0.40)

[a]Values in parenthesis are standard errors of the mean.

Table 9

Incidence of bloat (During period between Trials 13 and 14)

Group	No. cases with a bloat score of: 1	2	3	4	5	Total
1	11	11	5	0	0	27
2	4	1	5	0	2	12

Experiment 5

The commercial liquid supplement fed during Experiment 4 provided complete prevention of bloat for steers and heifers and the keeping characteristics of the supplement in the feeder were improved over those containing salt.

Experimental procedure.

In Experiment 5 two commercial liquid supplements having the same ingredient composition as used in Experiment 4 were used. However, the supplements were altered to contain 16.5 g/kg poloxalene instead of 22.2 g/kg.

Trial 17. (July 24 to August 2, 1970). The same heifers, pasture and management of trials 15 and 16 were used. The animals had access to the liquid supplement formula U (Table 7) for 10 days.

Trial 18. (October 2-29, 1970). Liquid supplement formula V (table 7) was used. Supplement V contained less water and more molasses than formula U used in trial 17. Three heifers were added to the 17 used before and were managed as one group (group 5). The heifers were allowed to graze the alfalfa pasture used in the previous trials. However, the pasture was divided into four plots (approximately 0.7 ha each). The group had access to one liquid supplement feeder while another similar but empty feeder was placed near it to measure the quantity of rain entering the feeders. An attempt was made to calculate the actual intake of the liquid supplement on rainy days by subtracting the amount of water entering as rain.

Results and discussion.

The average intake of liquid supplement by the heifers in trial 17 was greater than the intake in trials 15 and 16 (table 10). Because the concentration of poloxalene was lower in trial 17 than in trials 15 and 16, the ingestion of poloxalene was similar in all trials.

The supplement (formula V) containing less water and more molasses was consumed in greater quantity (trial 18) than the supplement (formula U) containing more water and less molasses. This was not unexpected.

In all three trials no bloat was observed. It appeared that rain water is an important factor to consider when feeding liquid supplements on pasture. Rain was recorded during 5 days of trial 18, but only on 3 days was it in an amount sufficient to measure in the control feeder. The dilution of the solutions was related not only to the water incorporated in the feeder but also to the amount already present in the feeder. On one of the rainy days the concentration of poloxalene dropped to 1.49%. It would be desirable to construct feeders with a lip around the wheel opening to prevent rain from diluting the supplement.

Table 10

Average liquid supplement consumption per head per day (Experiment 5)

Trial	Treatment Formula	Group	Liquid supplement intake		Poloxalene intake	
			(kg)	(kg/100 kg wt)	(g)	(g/100 kg wt)
17	U	3	1.03(0.12)[a]	0.279(0.033)	17.02(2.04)	4.60(0.55)
	U	4	0.82(0.11)	0.231(0.030)	13.58(1.77)	3.82(0.50)
18	V	5	1.49(0.18)	0.360(0.044)	24.05(2.87)	6.78(0.79)

[a]Values in parenthesis are standard errors of the mean.

GENERAL DISCUSSION

The objective of these studies was to determine if a liquid molasses supplement could be so formulated to provide a daily intake of poloxalene that would be sufficient to prevent bloat. The Food and Drug Administration has specified a daily level of 2.2 to 4.4 g poloxalene per 100 kg body weight for legume bloat prevention (Feed Additive Compendium, 1970). In trials 1 and 3 (molasses plus poloxalene) the intake of poloxalene was excessive and ranged from 4.31 to 10.55 g per 100 kg body weight. In trial 2 the addition of water and salt reduced the intake only slightly (5.26 g). Since salt precipitated in the feeders other methods of curbing intake were sought. The use of commercial liquid molasses supplements containing phosphoric acid and ammonium polyphosphate and 2.2% poloxalene resulted in intake from 2.60 to 9.18 g poloxalene per 100 kg body weight (trials 13 to 16). The reduction in poloxalene content of these supplements to 1.65% resulted in acceptable poloxalene intakes of 3.82 to 4.60 g (trial 17). The reduction in the amount of water from 20 to 10% in the formula used in trial 17 apparently increased the poloxalene intake to 6.78 g.

The absence of bloat in the pasture trials where supplements containing poloxalene were used suggested that the intake of the bloat preventive agent was sufficient in all animals to prevent bloat. Only two mild cases of bloat (score 1) were observed on the first day of trial 1. Since the animals had not been previously exposed to the liquid supplement, it is possible that the two steers had not learned to consume the supplement.

The occurrence of bloat in grazing animals during the periods when a supplement without poloxalene was offered is evidence of the bloat potential of the pasture. It may have been possible to provide conditions which would have provoked a higher incidence of bloat, such as grazing the pasture for a few hours only each day, with no other feed supplementation than the liquid supplement or offering new areas of the pasture twice a day. These procedures would have resulted in a distorted intake of the liquid supplement and they would have reflected a sophisticated experiment rather than a practical one. Obviously if bloat could be controlled completely, many farmers would maintain the cattle in the pastures at all times. The results of Experiments 3, 4 and 5 suggest that this practice is possible by using liquid supplements containing poloxalene.

The stability of the liquid supplements should be one of the most important factors to consider in their formulation since the precipitation of the constituents may affect the availability of poloxalene at a given time. The formulas containing high levels of water and salt (Experiments 1, 2 and 3) precipitated in the feeders and no further attempts were made to improve them.

The three commercial liquid supplements used in Experiments 4 and 5, did not present any precipitate in the feeders. This was a remarkable improvement over the earlier mixtures.

The intake of liquid supplements can also be limited by using hemicellulose extract instead of cane molasses. In the trials 10, 11 and 12 the groups supplemented with cane molasses ingested about 50% more liquid supplement than those groups receiving hemicellulose extract. Another advantage for the use of hemicellulose extract is its lower specific gravity compared with cane molasses. This makes it easier to handle and mix.

The average distance from the place of grazing in the pasture to the liquid supplement feeder may influence the intake of the supplements suggested in Experiment 4.

Steers pasturing alfalfa (trial 13 and 14) an average distance of 380 m from the supplement feeder consumed less supplement than when pasturing alfalfa 150 m from the feeder. However, heifers in trials 15 and 16 had available the same liquid supplement and had almost the same intakes for both trials. The average distance was 150 m for trial 15 and 200 m for trial 16. Since the fences were moved the same distance for the two groups of heifers within each trial, this factor affected both groups in the same way.

When the same liquid supplement was offered to the two groups of animals within a trial, as in trials 1, 4, 5, 6, 13, 14, 15, 16 and 17, the average intake of the supplements was different between groups within trials. This suggests that animal variation exists. However, since the supplements controlled bloat it can be assumed that all animals consumed the minimum quantity of supplement necessary to prevent bloat.

Another factor that may influence the intake of the liquid supplements is the size of the animal. In Experiment 4, in which the same supplement was offered to the steers and heifers, the small heifers had a lower intake per 100 kg of body weight than did the larger steers (table 8).

Since the supplementation of poloxalene in molasses-blocks requires careful management of the blocks as concluded by Stiles et al. (1967), and since poloxalene used as a top dressing on the concentrate rations requires twice a day feeding, it may be concluded that the liquid supplements containing poloxalene, especially those used in Experiments 4 and 5, have a distinct advantage in reducing labor if animals are to be kept in the pasture at all times. The liquid supplement feeders can be filled once a week, providing there is an adequate capacity of the feeder in relation to the number of animals to be fed.

SUMMARY

It has been demonstrated that the administration of poloxalene to cattle grazing legume pastures controls frothy bloat if the drug is administered in the proper dosage at the proper time. The supplementation procedures curently in use are feeding twice daily concentrates top dressed with poloxalene or mixed feed containing poloxalene. A third procedure is the placement in pastures of molasses blocks containing poloxalene. This research was undertaken to develop a liquid feed supplement with poloxalene as another method of providing the drug to cattle grazing bloat provoking alfalfa pastures. The liquid supplement was placed in wheel-type feeders and was available to cattle at all times. The consumption of the supplement was measured daily to determine if the intake of poloxalene was adequate from day to day.

The addition of 2.2% of poloxalene to untreated molasses resulted in an excessive intake of the liquid supplement. The average daily intake was reduced by including salt and water in the supplement, but the solutions were not stable. These mixtures when offered continuously for 105 days to steers in drylot were only refused 7% of the time. These refusals occurred during extremely cold weather in mid winter. Thus, apparently cattle do not tire of these supplements over long periods of time.

The substitution of cane molasses with hemicellulose extract reduced the intake of the supplement. The addition of water to cane molasses (50:50 w/w) markedly increased the intake of the liquid supplement in relation to cane molasses alone.

Commercial liquid molasses supplements containing phosphoric acid and ammonium polyphosphate to regulate intake were tested. Supplements containing 2.2% poloxalene when offered to heifers (average weight 364 kg) resulted

in average intakes varying from 2.60 to 4.25 g poloxalene per 100 kg body weight. The reduction in poloxalene content of these supplements to 1.65% resulted in more acceptable poloxalene intakes of 3.82 to 4.60 g. Steers (average weight 794 kg) receiving the supplement containing 2.2% poloxalene consumed from 4.42 to 9.18 g per 100 kg body weight. The intake of poloxalene was not proportional to body weight when comparing the steers with the heifers. The commercial liquid supplements remained stable throughout the time they were tested.

Bloat was not observed in the poloxalene supplemented groups with the exception of two cases of mild bloat on the first day. The absence of bloat suggested that the intake of poloxalene was sufficient in all animals to prevent bloat. The occurrence of bloat during periods when a molasses supplement without poloxalene was offered was evidence of the bloat potential of the pasture.

The average daily intake of poloxalene per head during all the supplemented trials was above the minimum recommended intake for the control of frothy legume bloat.

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LIQUID MOLASSES SUPPLEMENTS AS CARRIERS FOR POLOXALENE FOR THE CONTROL OF PASTURE BLOAT

by

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ABSTRACT

It has been demonstrated that the administration of poloxalene to cattle grazing legume pastures controls frothy bloat if the drug is administered in the proper dosage at the proper time. The supplementation procedures cu-rently in use are feeding twice daily concentrates top dressed with poloxa-lene or mixed feed containing poloxalene. A third procedure is the place-ment in pastures of molasses blocks containing poloxalene. This research was undertaken to develop a liquid feed supplement with poloxalene as another method of providing the drug to cattle grazing bloat provoking alfalfa pas-tures. The liquid supplement was placed in wheel-type feeders and was avail-able to cattle at all times. The consumption of the supplement was measured daily to determine if the intake of poloxalene was adequate from day to day.

The addition of 2.2% of poloxalene to untreated molasses resulted in an excessive intake of the liquid supplement. The average daily intake was re-duced by including salt and water in the supplement, but the solutions were not stable. These mixtures when offered continuously for 105 days to steers in drylot were only refused 7% of the time. These refusals occurred during extremely cold weather in mid winter. Thus, apparently cattle do not tire of these supplements over long periods of time.

The substitution of cane molasses with hemicellulose extract reduced the intake of the supplement. The addition of water to cane molasses (50:50 w/w) markedly increased the intake of the liquid supplement in relation to cane molasses alone.

Commercial liquid molasses supplements containing phosphoric acid and ammonium polyphosphate to regulate intake were tested. Supplements contain-ing 2.2% poloxalene when offered to heifers (average weight 364 kg) resulted

in average intakes varying from 2.60 to 4.25 g poloxalene per 100 kg body weight. The reduction in poloxalene content of these supplements to 1.65% resulted in more acceptable poloxalene intakes of 3.82 to 4.60 g. Steers (average weight 794 kg) receiving the supplement containing 2.2% poloxalene consumed from 4.42 to 9.18 g per 100 kg body weight. The intake of poloxalene was not proportional to body weight when comparing the steers with the heifers. The commercial liquid supplements remained stable throughout the time they were tested.

Bloat was not observed in the poloxalene supplemented groups with the exception of two cases of mild bloat on the first day. The absence of bloat suggested that the intake of poloxalene was sufficient in all animals to prevent bloat. The occurrence of bloat during periods when a molasses supplement without poloxalene was offered was evidence of the bloat potential of the pasture.

The average daily intake of poloxalene per head during all the supplemented trials was above the minimum recommended intake for the control of frothy legume bloat.