CRUDE OIL POISONING IN CATTLE

by

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B. V. Sc & A. H., Agra University,
India, 1953

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Pathology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

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INTRODUCTION

A number of inquiries from livestock owners, veterinarians, and oil companies come from time to time on the subject of alleged crude oil poisoning in domestic animals. There is no definite data as to what extent domestic animals, particularly cattle, that graze in oil field areas, may suffer when crude oil and waste products are consumed from polluted streams or ponds. The effects on mammalian life drinking water containing crude oil in different dilutions have not been studied extensively. Complaints do very often occur of this alleged poisoning. It is known that there are great numbers of crude oil polluted streams in the field to which grazing animals have free access. Livestock owners often lodge complaints, that frequently terminate in lawsuits, against oil companies to recover the loss of their livestock. These pollutions of streams or ponds occur by bursting of oil pipes that run through a farm or a nearby oil well. There is no definite information in the literature that the crude oil exerts any ill effect on the health or causes death of farm animals.

It is essential to know the composition of crude oil to determine its toxic factor. Crude oil is an exceedingly complex substance; its composition varies with sources and is never completely known. Gasoline, which is derived from crude oil, consists of a mixture of petroleum hydrocarbons, generally consisting of four groups of components: paraffins, olefins,

naphthanes and aromatics. The straight run gasoline made from petroleum produced in the United States is principally paraffinic in character and generally contains about 65 percent paraffin hydrocarbons. Several crude oils in the western part of the United States, however, yield gasolines which are aromatic and naphthanic in character (Machle, 1941). Crude oil subjected to various processes of distillation and chemical treatment yields various well-known products like kerosene, benzene, vaseline, gasoline, benzinphenols, paraffin, etc. Some of these are highly poisonous. Osol and Farrar (1947) stated that the heavier fractions are practically incapable of absorption from the digestive tract and, therefore, do not have injurious effects when swallowed. On the other hand, the more volatile fractions, such as benzene and gasoline, are exceedingly toxic. The middle fractions, like kerosene, possess toxic properties midway between these extremes. They further reported that the toxicity of these products is directly proportional to their volatility. The toxic effects of some of these products on human and animal life have been studied and their toxicity determined. This information is of little value in determining the toxicity of crude oil poisoning in livestock, as there is no assurance that the toxicity of these derivatives is the same when still combined in the raw materials.

Heller (1933) stated that the water from deep wells resembles in many respects ocean water. Water of this nature when emulsified with crude oil causes much trouble in livestock in the

oil fields. He found that the salts present in these waters are sodium, calcium, and magnesium chlorides and smaller amounts of other salts. The disposal of these brines is a problem to the oil industry. If pumped into a small stream, the water may become dangerous to plant and animal life.

The degree of injury to the health of farm animals drinking water from streams, ponds, or pools is one of the questions to be studied. It is also important to know whether farm animals will actually drink enough water polluted with crude oil to harm themselves, to know the lethal dose, and to know the ill effects.

This problem was undertaken because of the frequent inquiries on the ill effects of crude oil on livestock, the vast distributions of such oil polluted waters in Kansas, and the present inadequate knowledge of the effects of crude oil when consumed by livestock. These studies will include the symptomology and pathological changes produced in experimental animals.

REVIEW OF LITERATURE

As previously stated, very little information is found in literature pertaining to actual crude oil poisoning of livestock in general and cattle in particular. Medical literature shows that many of the products like kerosene and gasoline have been studied extensively, primarily as to the toxic effect on humans. There is very little chance for man to be poisoned by drinking crude oil in any dilution; hence, no studies of its effect have been recorded.

Osol and Farrar (1947) stated that petroleum consumed in large quantities may be poisonous. Poisoning by consuming crude oil is very rare, though many of the products derived from it may be highly toxic. They described that gasoline poisoning is due to its lipolytic action. Symptoms vary with total doses as well as with concentration. In severe cases there may be incoordination and mental disturbances, similar to alcoholic intoxication, lasting from a few hours to several days. Some of the symptoms when poisoning occurs by inhalation are depression of circulation, respiration, body temperature, bronchitis, and pneumonia. Death is not common and when it does occur, there is evidence of degeneration of endothelium and extravasations and hemorrhages in the serous cavities. In surviving cases, sequelae involving the nervous system may last for months.

Sax (1951) dealing with petroleum products such as gasoline, heptane, etc. stated that they affect the body when inhaled or ingested and are largely excreted unchanged in the exhaled air and some in the urine. He stated that 1,000 ppm of gasoline or heptane can produce in people exposed to them adverse symptoms such as drowsiness, unsteadiness, giddiness, headache, and nausea within six to 60 minutes.

Brundage (1909) reported that petroleum or the products of distillation have been drunk accidentally with serious results. He reported that three ounces of naphtha killed a twelve-year-old boy; whereas, recovery occurred in another case after swallowing a pint of petroleum and half pint of paraffin.

Machle (1941) stated that the usual mode of absorption of gasoline is through the respiratory system in man. The pathological changes that occur are dependent on its irritant action and lipolytic activity. There are no characteristic pathological findings, but uniform damage to lungs manifested by hyperemia, petechial hemorrhages, subpleural extravasation and in some cases gross pulmonary hemorrhages are observed. Bronchitis is frequent with some degree of pneumonia, especially when gasoline has been ingested and aspiration has occurred or as a result of its excretion through the lungs. In poisoning by ingestion with no aspiration, symptoms develop more slowly than in poisoning by inhalation because of the slow rate of absorption from the alimentary tract. The outstanding symptoms arise from the central nervous system and gastrointestinal tract. Pneumonia, visceral congestion and hemorrhages are the frequent pathological changes observed.

Nunn and Martin (1934) treating children with gasoline and kerosene poisoning observed that in fatal cases the children lived from two to eight hours after the ingestion and aspiration of these substances. All those that died showed definite clinical evidence of pathological changes in the lungs, such as moist rales in both lungs, rapid shallow respiration and cyanosis. They also observed that those who swallowed a large quantity of the substance and became ill had also aspirated some of the fluid. The toxicity produced by the ingestion of coal oil or gasoline is not so grave as with aspiration or inhalation of these

hydrocarbons. Prognosis was related in direct proportion to the amount of hydrocarbons entering the lungs. The patients that drank the fluid showed mild symptoms, but those who aspirated as well as ingested these products presented a more grave clinical picture. This was due to the rapid development of pneumonia. They found that the red blood cell count and hemoglobin were within normal range.

Waring (1933) found the following symptoms in children made ill by kerosene: signs of marked drowsiness, actual coma, fever, diarrhea, and definite signs of pulmonary involvement, varying from mild bronchitis to severe and fatal pneumonia in all cases. In experimenting with dogs, he administered doses of kerosene ranging from 100 cubic centimeters to 200 cubic centimeters by stomach tube and from five to 10 cubic centimeters by intratracheal injection. Dogs receiving oil by stomach tube became drowsy and there was a slight rise of temperature but with no ill effects manifested. Blood counts were found to be normal in these animals. Kerosene was observed to be passed from the rectum on the second day and these animals recovered. Dogs receiving tracheal injection showed marked dyspnea, ataxia, inability to stand, rapid respiration and pulse and eventually death. Autopsy revealed both lungs congested with excess fluid and consolidation of the left lower lobe. In the solidified parts of the lobe, the alveoli were filled with fibrin and fluid. Microscopically there was capillary engorgement and marked edema of the alveoli. He concluded that the pulmonary complications

of kerosene poisoning were due to the aspiration of some of the kerosene directly into the lungs or the aspiration of regurgitated kerosene from the stomach. Serious and fatal intoxication with this substance was due to the development of pulmonary inflammation with edema and perhaps a rapid absorption of the oil from the lungs. From his experiments on dogs, it was obvious that the route of administration was important, as 200 cubic centimeters of kerosene administered by stomach tube produced only temporary slight ill effects; whereas, a small quantity, ten cubic centimeters injected into the trachea resulted in death in from six to eight hours.

Holland (1911) stated that petroleum and its products are all somewhat poisonous when taken into the body either by inhalation or by swallowing. When swallowed, petroleum acts as a local irritant to the stomach causing pain, vomiting, colic, diarrhea, etc. Absorption of petroleum produces headache, dizziness, rapid pulse, labored breathing, cyanosis, drowsiness, and collapse. A death was reported from consuming a half ounce of benzine, but in another case, recovery followed consumption of one pint of petroleum. Fatal cases are very rare. Post-mortem examinations showed no constant characteristic lesions in the fatal cases. The odor of petroleum products may be detected in contents of the stomach and bowel.

Richardson and Pratt-Thomas (1951) tried to determine whether the pulmonary involvement following the ingestion of kerosene was due to hematogenous transfer of the material or to

aspiration. They studied the pulmonary injury in dogs and rabbits produced by kerosene given by various routes: intragastric, intravenous, intestinal fistula, intratracheal, intraperitoneal, and by stomach tube. They concluded by the extent of dosage and degree of lung damage that the aspiration was the most serious and usual feature of kerosene poisoning as it occurs clinically.

Wilson (1949) described acute petroleum poisoning in human beings with the symptoms of headache, blurred vision, dizziness, unsteady gait and nausea. Massive exposure to these products may cause sudden collapse, coma, and death. In fatal cases, blood vessel damage, hemorrhages into the body organs, bronchitis, pulmonary edema and cellular damage of the kidneys, liver, and spleen have been described. The symptoms of chronic poisoning are of central nervous origin and sometimes accompanied by pulmonary edema and bronchopneumonia.

Barbour (1926) described in a child a comatose condition with shallow respiration and a rapid, feeble pulse six hours after drinking a portion of six ounces of kerosene. The lips were cherry red, temperature elevated, and the fecal matter gave a marked odor of kerosene. He treated the child and after 48 hours the patient was discharged in an improved condition.

McConnell (1945) stated that ordinarily crude oil was injurious only when consumed in fairly large quantities or when it contacted a large surface of the body. Sometimes a certain percent of cattle in a large herd may directly consume pure crude

oil or high test gasoline. The more recently the crude oil is produced, the more volatile constituents it contains, and when consumed the animal becomes intoxicated, bloats, and may or may not regurgitate oil. He described the following symptoms: dilation of pupil, acceleration of heart beat and respiration, elevation of body temperature, and incoordination of muscles followed by death. Mild cases usually recover. His observations on post-mortem examination were as follows: high state of inflammation and thickening of the mucous membranes of the whole intestinal tract and urinary bladder, hemorrhages, and inflammation of the kidneys, highly inflammed condition of the liver, atrophy and hardening of the spleen, and usually congestion of the thoracic organs.

Dealing with salt water poisoning, McConnell (1945) stated that if no water is available and animals are forced to drink salt water of sufficient concentration and quantity they will be injured directly. Failing to drink much of the water due to its salt content, the animals will develop a condition of partial starvation, so-called "salt injury," due to inadequate intake of food and water to supply their maintenance requirements. Unless the animals are forced to drink salt water until the parenchymatous organs are irreparably damaged, they usually return to normal when given a source of fresh water to drink. Various symptoms are observed when animals are poisoned by salt water. These consist of great thirst, abdominal pain, diarrhea, and poor appetite. Post-mortem appearances showed congestion of the

entire digestive tract and varying degrees of congestion of parenchymatous organs with marked engorgement of subcutaneous vessels. The blood may appear bright red and thin. In chronic cases the following changes have been described: hardening of the liver, atrophy of kidneys with capsule adhering, cystitis, shrunken spleen, and chronic gastro-enteritis.

Dykstra (1946) stated that there is no reliable information about crude oil poisoning in cattle. In some oil well areas, cattle do consume water contaminated with some of the products of crude oil distillation. It is often said that these products are responsible for cattle deaths, but this is very difficult to prove as an actual fact. He gave a quart of crude oil (oil of Seneca) to an old emaciated cow and found that the cow went off feed somewhat; otherwise, there were no bad results. He observed many post-mortem examinations in animals alleged to have died of or who were in ill health because of crude oil poisoning. He found that there had been an irritant of some nature in the digestive tract, but without any conclusive evidence that the irritant was the crude oil.

Bumstead (1949) stated that nearly all animals in a herd that had been wading in a pool of oil were very sick and passing foetid, oily, and bloody feces. One small heifer was passing bloody feces containing intestinal epithelial lining. She was very dehydrated and unable to stand. According to him, she had become a "bag of bones" in just a day after drinking oil and was about to die. He treated the heifer and the other animals in

the same way, by allowing free access to food and fresh water. Three days later all treated animals were doing well except the small heifer. She did not eat or drink and was walking blindly and stumbling. He presumed further treatment was useless for the small heifer. Six months later all the animals had grown fat and were in fine shape. To his great surprise, he found the small heifer, which he had given up for dead, grown into a 700-pound animal.

Jones (1945) quoted that livestock, particularly cattle, are not seriously affected unless the brine contains injurious salts, such as barium, or unless the salt concentrations of total solids are exceedingly high. Ordinary oil field water analysis does not show the presence of barium, but laboratories of the Bureau of Mines have shown the presence of barium in some oil field waters. Generally, the barium precipitates into insoluble and harmless barium sulphate upon being diluted with surface water. It was stated that in Texas there was a well which produced only salt water and the cattle on the ranch were watered from this well as no fresh water supply was available. The cattle thrived while drinking this water. The water from this well had been used for years with apparently no ill effects to the cattle. It was found that total solids in the water were far below the maximum limit.

Heller (1933), analyzing some samples of water coming from deep oil wells in Oklahoma and adjoining states, showed various saturations of sodium, calcium and magnesium chlorides and

sulphates, minor quantities of carbonates, bicarbonates and lesser quantities of other ions. Sodium chloride is less injurious than calcium chloride, and magnesium chloride is the most injurious. Injury evidently resulted from the limited amount of water the animals consumed. The alkali solutions are more injurious than saline solutions. Injury is more direct and results in a chronic enteritis. The total soluble salts present in the water seem to be a more important factor in damage to livestock than the kind or kinds of salts present. A total salt content of 1.5 percent should be considered as the maximum concentration of soluble salts that animals can use with safety. For lactating cows the maximum concentration is somewhat lower. Sheep are more resistant than cattle and cattle more than hogs. Sheep have been able to exist on 2.5 percent sodium chloride and two percent magnesium sulphate solutions. Cattle not in lactation will readily maintain themselves on a diet containing two percent sodium chloride. He observed that no animal ever chose to drink water that was harmful if good water was available.

Pistor, et al. (1950) described the influence of high salt intake on range cattle when given access to a mixture of 30 percent salt and 70 percent meal supplement. The salt limited the consumption of the feed to two to three pounds of the mixture daily during the short grazing seasons. The ruminants can tolerate relatively large amounts of salt if sufficient fresh water is available, so that the kidneys can eliminate the absorbed

excesses. High salt intake had no effect on pregnancy. There was no change in the sodium chloride content of blood and milk.

Jones (1930) reported a case of salt poisoning in a cow which received one pound of salt in buttermilk and repeated in six hours. An hour after the second dose there occurred severe spasms, marked weakness, and diarrhea. Ultimately the cow recovered.

Ellis (1942) reported in experimental feeding of salt to swine that one animal weighing 218 pounds, after being fed 26 days on a high salt ration, was consistently consuming an average of 8.4 pounds of total ration and 495 grams of salt a day. He reported a maximum growth in pigs on a diet containing two percent salt. Symptoms of poisoning developed in an animal after 86 days on a diet containing eight percent salt. These results suggested that some factors other than salt were responsible for poisoning in swine and supported the conclusion made by Worden (1941) that it is doubtful whether in normal circumstances pigs will consume voluntarily toxic doses of sodium chloride. Many of the recorded cases of salt poisoning may be due to other factors.

Schüler (1942) described a loss of 59 sheep and 53 lambs after 33 pounds of common salt was made available with good pasture. Six hours after access to the salt, the sheep showed nervous system involvement manifested by trembling, severe diarrhea and collapse.

Udall (1947) reported a case of salt poisoning in a cow caused by adding an unknown amount of salt to the hay and silage and 2.5 percent salt to the grain. Describing the symptoms, he stated that immediate effect of an excessive amount of salt caused inflammation of the gastric mucosa. After absorption into the circulation, it exerted a depressant action upon the central nervous system. The immediate symptoms were diarrhea and diminished milk flow. When an extreme amount was taken, there was complete loss of appetite, marked redness and dryness of the oral mucosa, colic, diarrhea, polyuria, and blindness. Nervous symptoms were marked weakness and paralysis of the hind parts or general paralysis. The post-mortem change was primarily a gastro-enteritis. In cattle the mucosa of the abomasum was swollen, congested, and hemorrhagic. Blood was usually bright red and thin.

Law (1911) stated that common salt was especially irritating if given in concentrated solutions with subsequent deprivation of water. The poisonous doses of common salt were; for horses, two to three pounds; cattle, four to five pounds; pigs, seven to eight ounces; and dogs, six to seven ounces. Symptoms described were anorexia, intensive thirst, dullness, colic, watery diarrhea, frequent urination, muscular weakness, spasms, paralysis, weak pulse, red buccal mucosa, and dilated pupils. Death usually took place in from six hours to two days or longer. Lesions, he described, were congestion of the stomach and intestines with points of ecchymosis, redness of the mucosa of the urinary

bladder and blood of a bright red color. He described similar symptoms in hogs and dogs poisoned with brine, especially from kitchen waste and herring brine.

MATERIALS AND METHODS

The crude oil used in this study was obtained from three different regions in Kansas: (1) from east-central Kansas, (2) from west-central Kansas, and (3) from northwestern Kansas. The crude oil was collected directly from the pipes immediately after it had been pumped from the well and that from northwestern Kansas at a pumping station. Therefore, there was no chance of contamination with other materials.

Nine healthy Hereford calves of both sexes, eight months to two years of age and weighing from 450 to 650 pounds, were used in this experiment. The calves were divided into three groups of three calves each and were administered varying quantities of crude oil by means of a stomach tube and pump. In one group of calves, common salt was used with crude oil. Details of dosage are shown in Tables 1 and 2. The crude oil was administered directly into the rumen by means of a stomach tube and pump. Care was taken to see that the oil was not pumped into the trachea or lungs. This was accomplished by holding the end of the tube to the ear after the tube was passed and listening for sounds of the rumen.

Temperatures of all experimental animals were recorded before and after giving crude oil. The blood picture was

studied at varying intervals before and after administration of oil. The animals were observed several times daily for any change in condition or toxic symptoms due to crude oil.

The calves were fed alfalfa hay, oats, and fresh water morning and evening, except in two cases, where fresh water was withheld for eight days.

Table 1. Dose of oil in pints.

Days	Calf number 1	2	3
1	1.0	0.5	-
4	1.5	1.0	-
7	2.0	1.5	-
10	2.5	2.0	-
14	3.0	2.5	-
17	3.5	3.0	-
25	12.0	3.5	-
29	16.0	4.0	-
32	-	4.5	24
36	-	5.0	-
Total consumed	41.5	27.5	24
Outcome	Survived	Sacrificed*	Survived

* Calf appeared moribund.

The calves were given the usual food and water after administration of the oil. The calves were kept under observation in the stall for a period of 45 days. Calf number 2 was sick and the condition was precarious a week after the last dose and remained in that condition for five days when it became moribund. Then the animal was sacrificed and a post-mortem examination conducted. The other two calves were removed after this period and kept under observation for ten weeks.

Table 2. Dose of oil and/or salt and termination.

Day	Calf number 4	5	6	7	8	9
1	40 oil	10 salt	10 salt	24 oil	/16 oil	*
2	-	10 salt	10 salt	-	-	*
3	-	10 salt	10 salt	-	-	*
4	-	-	-	16 oil	-	*
5	-	-	-	-	-	*
6	-	10 salt 24 oil	10 salt	16 oil	/ 8 oil	*
7	-	-	-	-	-	*
8	-	-	10 salt	-	-	*
9	-	-	-	-	-	*
10	-	10 salt 24 oil	10 salt	-	-	*
11	-	(Death)	10 salt	-	-	*
Total consumed	40	40 salt 48 oil	70 salt	56 oil	24 oil	0
Outcome	Survived	Died	Survived	Died	Survived	Survived

Dose of oil in pints.
Dose of salt in ounces.
/This oil was mixed with water at 2:1 ratio and was the only source of liquid for the calf.
*Fresh water and a mixture of oil and water in ratio of 2:1 kept before animal for entire experiment but none of the mixture consumed.

The calves were given the usual food and water daily throughout the experiment and period of observation. All were kept under observation in the stall for a period of two weeks after which calves number 4 and 6 were removed and observed daily for a period of eight weeks. Many people reported salt poisoning and high content of salt in oil polluted water so one animal, calf number 5, was given salt daily for a period of four days prior to administration of oil by means of stomach tube and pump. The crude oil was mixed with salt and given by means of stomach tube and pump after the administration of 40 ounces of

salt. Calf number 6 served as a control and was given only salt mixed with water by stomach tube and pump during the same period. Calf number 5 died during the night, approximately 36 hours after the administration of the last dose of crude oil.

For a period of eight days, calves number 7 and 8 did not receive any fresh water to drink, but received usual food of alfalfa hay and oats. During this period, calf number 8 was given a mixture of crude oil and water to drink instead of fresh water. Calf number 9 was given a choice of one can of oil-mixed water or one can of fresh water to drink throughout the period of eight days.

The calves were kept under observation in the stall for a period of six weeks. Plenty of fresh water and food were given daily. Twenty days after the administration of the last dose of crude oil, calf number 7 died during the night and a post-mortem examination was conducted the following morning.

RESULTS

The temperatures were recorded in the first and second group of calves before and several times after the administration of crude oil. It was seen that the temperature was within normal range, except in calf number 2, which showed some variation, seven days after the last administration of crude oil. Blood picture of each of the above calves was studied for red blood cells, white blood cells, and differential counts, once before and several times after administration of oil and at

times when they were found sick. No changes in blood picture were found. As these calves did not show much variation in temperature as well as in blood picture, in the third group of animals, temperature was not recorded and blood was not examined.

In the first group of calves, it is seen that the total amount of crude oil consumed by the calve number 1 was 41.5 pints, calf number 2 was 27.5 pints, and calf number 3 was 24 pints (Table 1). The calves numbers 1 and 2 received these amounts in fractional doses, while calf number 3 received the amount at one time. Until the thirty-first day after starting the experiment, no ill effects were noticed in calves numbers 1 and 2, except unchanged crude oil was passed through the rectum the day following the crude oil administration. Calf number 1 was taken off experiment after 27 days; the last dose was 16 pints at one time. The calf was kept under observation for a period of ten weeks and no change or symptoms were observed during this period.

Dosing of calf number 2 was continued for a period of 35 days; the last dose being five pints of crude oil. Lacrimation from both eyes was noticed on the thirty-first day after the first dosing of oil. The unchanged crude oil was passing through the rectum along with feces one day after oil administration and continued for a period of one week after the last dose. On the morning of the eighth day after the last dose, the calf was found sick, lying down and prostrate. Profuse lacrimation from the left eye was observed, and the temperature was recorded and

found to be 105.8 degrees F. A blood count was made and found within the normal range. The next day the temperature was down to 103.3 degrees F., but lacrimation was still marked. On the third day, the temperature was 102.2 degrees F. and the animal was depressed and prostrate; the prognosis was grave. It was doubtful if the animal would survive through the night, so the animal was sacrificed.

Calf number 3 which was given 24 pints at one administration, was found to be sick on the next day. The calf was found lying down and greatly depressed and reluctant to get up when approached. Temperature and blood picture were found within normal range. The unchanged crude oil was passing through the rectum and continued for a period of four to five days. The animal gradually recovered, and no ill effects were noticed thereafter.

In the second group of calves (Table 2), calf number 4 received 40 pints of crude oil in one dose. Calf number 5 received a total of 48 pints of crude oil plus about three pounds of sodium chloride. Calf number 6 received about four and one-half pounds of salt and was kept as a control (Table 2). On the day following administration of oil, calf number 4 was found lying down and seemed to be sick. Temperature and blood count were found within normal range. The unchanged crude oil passed through the rectum for a period of four to five days. The animal gradually recovered and returned to a normal state, and no ill effects were noticed during the period of observation.

Calf number 5, after receiving 2+ pints of crude oil along with ten ounces of salt, was found down the next day and reluctant to get up. The unchanged crude oil was passing through the rectum. The calf was found apparently normal the next day. Four days later the calf was given 2+ pints of additional crude oil with salt. The following morning the calf was found lying down and greatly depressed and would not get up. It did not respond at all. Lacrimation from the right eye was observed. Temperature was normal, and shallow rapid breathing was observed. The same symptoms prevailed until late evening, and the calf died during the night. Calf number 6, receiving salt and water for a period of ten days, showed no illness during the period of observation.

The third group of calves was given the crude oil in the manner described in Table 2. Calf number 9 was given preference of one can of oil-mixed water and one can of fresh water to drink. The calf drank only fresh water and did not drink oil-mixed water at all.

Calf number 8, when given oil mixed with water and no fresh water to drink, for two days did not drink at all. On the third day, it was found that he drank some oil-water. For eight days no fresh water was given to drink; at the end of the period it was found he had consumed altogether about 36 pints of oil mixed with water in the proportion of 2:1. Although usual feed, consisting of oats and alfalfa hay, was given liberally, it consumed less than calf number 9. No ill effects were noticed during that period, except that the animal

lost considerable weight. After eight days, the calf was given liberal amounts of fresh water to drink daily. It was observed clinically that in a month, the calf regained its original weight.

Calf number 7 received a total of 56 pints of crude oil by stomach tube and did not receive any fresh water for a period of eight days. On the day following the initial dose of 24 pints of crude oil by stomach tube and pump, the animal was found lying down and somewhat depressed; otherwise, no ill effects were noticed. On the third day, the animal appeared quite normal and was eating like the other calves. Crude oil was passed through the rectum along with feces 36 hours later. On the fourth day 16 additional pints of crude oil were administered by the same method. Forty-eight hours after the second dose, the animal appeared normal except that the crude oil was passing with the feces. A third dose of 16 pints of crude oil was administered by the same method. On the next day, the animal was found lying down and slightly depressed, but got up when approached. Temperature was normal and difficult respirations were observed. After the eighth day, the calf was given fresh water to drink along with the other two calves. It was clinically observed that during this interval the animal lost a considerable amount of its original weight.

All three calves were kept under observation for a period of days in a stall, and fresh water and feeds were given liberally. Calf number 7 was not eating well and found lying down

frequently. It was unable to recover and regain its weight as compared with calf number 8. Twenty days after administration of the last dose of crude oil, the calf was found exhausted and down; he could not get up when approached and died during the night.

Post-mortem findings of calf number 2. When the abdominal cavity was opened, the odor of crude oil was pronounced. Diffuse hemorrhages were seen throughout the subcutaneous tissues and in the wall of thoracic and abdominal cavities. The heart was dilated, flabby and lacked tone, and petechial hemorrhages were seen on the endocardium. The pericardium was found normal and the blood was bright red in color. The larynx, pharynx, and trachea were apparently normal. The lungs were pneumonic, especially patchy pneumonic lesions were seen in the anterior parts of both the lungs. The rumen ingesta and contents of omasum gave the odor of crude oil. Diffuse hemorrhages were found in the wall of abomasum and reticulum. The mucosa of the abomasum was reddened and edematous (Plate I). Diffuse hemorrhages were seen throughout the wall of intestines, both small and large. The mucosa of small intestine was hyperemic and a marked catarrhal enteritis was observed. The mucosa of the cecum was also hemorrhagic.

The liver was slightly enlarged; otherwise, no gross lesion was observed. Large ecchymotic hemorrhages were seen on the mucosa of the gall bladder and the serosal surface was also hemorrhagic (Plate II). The spleen was observed to be slightly

enlarged. Petechial hemorrhages were found in the cortex and medulla of both the kidneys. The wall of the urinary bladder was highly thickened, edematous and pin point hemorrhages were seen in the mucosa.

Calf number 5. Oil stained feces was found adhering to the anus and rectum was highly inflammed. When body was opened, the smell of crude oil was pronounced. The heart was dilated with pin point hemorrhages on the epicardium. The pericardium was quite normal. The blood was cherry red in color. The larynx, pharynx, trachea, and bronchi were normal. The lungs were pneumonic with fibrin deposits on the surface. There was capillary engorgement and traces of oil were found in the alveoli. Oil was seen in all parts of the stomach. The mucosa of the abomasum was reddened and edematous with a catarrhal gastritis. Catarrhal enteritis in the small intestine was marked. The mucosa of cecum and colon were slightly congested. There was fatty degeneration of the liver. Extensive diffuse hemorrhages were seen in the mucosa of gall bladder. The spleen showed areas of pin point hemorrhage. There was slight congestion of the kidneys; otherwise, they were apparently normal. The urinary bladder was congested and reddened. There were no gross lesions in the other organs or tissues.

Calf number 7. When the body was opened, the odor of crude oil was very evident. The carcass was emaciated and dehydrated. The heart was somewhat dilated and there were petechial hemorrhages on the epicardium. There was a pericarditis, but no

EXPLANATION OF PLATE I

Marked oedema of abomasum.

PLATE I

EXPLANATION OF PLATE II

Extensive ecchymotic hemorrhages of gall bladder.

PLATE II

lesions were seen on the endocacardium. Blood vessels were filled and the blood was cherry red in color. The larynx, pharynx and bronchi were found normal. The trachea was hemorrhagic and filled with a foamy fluid. The lungs were adherent to the pleura on the costal surface. The right diaphargmatic lobe was emphysematous, very dark, and adherent to the heart. An abscess was found in the right diaphargmatic lobe. The mediastinal lymph glands were enlarged and hemorrhagic. Crude oil was found in all parts of the stomachs and intestines. The mucosa of abomasum was edematous and hemorrhagic. There was a catarrhal gastro-enteritis. The cecum and colon were thickened and hemorrhages were found in the mucosa. The liver was greatly enlarged, swollen, mottled, and degenerated. The gall bladder was congested. The spleen appeared normal. The kidneys were slightly congested. The mucosa of the urinary bladder was reddened and hemorrhagic.

DISCUSSION

From the study of the results of this experiment, it is difficult to say to what extent crude oil is poisonous to cattle by ingestion and its lethal dose. The calves were given crude oil in varying doses by means of a stomach tube and pump. Some of them showed severe symptoms and eventually died, while others showed mild symptoms lasting for hours only. It was shown that calves could consume as much as five gallons of crude oil at one dose, when given by stomach tube and pump without any severe

ill effects, but given in smaller doses and for a longer period of time, three and one-half gallons of the crude oil could cause the death of a calf. It seemed that continuous accumulative smaller doses for a longer time was more fatal than ingestion of a large quantity of the crude oil at a given time. The calves, which showed mild symptoms, would lie down and not eat for a few hours. This may have been due to intoxication by the crude oil. Some of the earlier workers had pointed out this effect, from some of its by-products like gasoline and kerosene. This toxic action of the crude oil had a depressing effect rather than an exciting effect upon the animals. This state of intoxication lasted only a few hours, as evidenced by the calves returning to a normal state. This was observed in every case by at least the next day after administration of the oil. The calves, when given smaller doses and continued for a longer time, became ill and showed symptoms like anorexia, drowsiness, shallow rapid breathing, etc. and eventually death. These symptoms leading to death were more pronounced in those calves that received small doses over a prolonged period of time. The calves that died showed definite signs of pulmonary, gastro-intestinal and urinary systems involvement.

All the calves that died showed clinical evidence of pathological changes of the lungs, primarily the development of pneumonia. This was probably due to the aspiration of regurgitated crude oil from the stomach as observed by Waring (1933) in kerosene poisoning. It seemed that the serious and fatal

intoxication with this substance upon the animals accounted for the development of pulmonary inflammation.

Most of the products were eliminated unchanged by way of digestive tract. However, some absorption did take place from gastro-intestinal tract. In every case, there was gastro-enteritis, which was perhaps due to the irritant effect of the crude oil. In some cases, the liver was greatly enlarged with degenerative changes. Mild reddening to severe hemorrhages were found in the gall bladder. These changes showed that the crude oil exerted some effects on these organs.

The kidneys were reddened, congested, and hemorrhagic. Thickening and hemorrhages of the wall of the urinary bladder were found in every case. This may have been due to the process of elimination of some of the irritant products through the urinary system.

Temperatures were recorded and blood was examined after administration of crude oil and both found within normal range. The crude oil was passing from the rectum within 24 hours after administration and continued for several days. It was also found in the stomach and intestines, even after 20 days from the last administration.

From the results of the experiment in the third group of calves, it was observed that they did not prefer to drink crude oil, even if it was diluted with water, when fresh water was available. It appears doubtful if cattle would consume lethal amounts of crude oil under natural range or farm conditions.

Animals may drink oil polluted water when no fresh water is available. Calf number 8, when given only oil-mixed water and no fresh water, did not drink at all for two days. During the period of eight days, the calf drank only 36 pints of oil-mixed water. This quantity was far below the normal requirement for a calf of this age. Had it been given fresh water instead of oil-mixed water, it would have drunk at least 24 pints a day. The loss of appetite and loss of weight was due to the deprivation of fresh water and possibly to the effects of crude oil itself. When the same calf was given fresh water, it regained its original weight in less than a month, which it lost in eight days. The observation made by McConnell (1945) was substantiated in that they usually return to normal when fresh water is given, unless the parenchymatous organs are irreparably damaged. Calf number 7 did not regain its weight due to the damage to the parenchymatous organs. This was later confirmed by autopsy examination.

SUMMARY AND CONCLUSIONS

1. The effects of crude oil on nine Hereford calves, given varying doses by means of stomach tube and pump, has been studied.

2. No definite results were found as to what extent the crude oil was poisonous to cattle by ingestion nor what was the lethal dose.

3. The effects of crude oil seemed not to depend so much on the amount, but on the length of time during which the animals

received crude oil; in other words, smaller amounts continued for a longer period of time produced more serious effects than larger quantities given in one dose.

4. Most of the crude oil was seen passing unchanged from the digestive tract within 24 hours following the administration of crude oil and continued for several days thereafter. The crude oil was seen in the stomach and intestines a number of days after its administration. In one case this interval was 20 days.

5. The calves were in a state of intoxication lasting for several hours the day following administration of crude oil, but eventually returned to normal. Several calves showed symptoms of anorexia, drowsiness, shallow rapid breathing, etc. and these were more pronounced a few days after administration of oil, especially in the calves which became ill and eventually died.

6. Body temperature was recorded and blood was examined after administration of crude oil and was found within the normal range in all cases.

7. There were no significant effects found when salt was mixed with crude oil and administered to calves.

8. Autopsy examination of the three calves revealed respiratory, digestive, and urinary system involvement. Pulmonary involvement and gastro-enteritis were the most conspicuous lesions found in every case. Dilation of heart, enlargement of liver with degenerative changes and hemorrhages in gall bladder

and kidneys were observed. Hemorrhages and thickening of the wall of the urinary bladder were also present.

9. Pulmonary complications were probably the most serious effects produced and eventually caused the death. This was probably due to aspiration of regurgitated crude oil from the stomach.

10. Emaciation was a marked symptom when crude oil was administered over a period of days.

11. It was found that the calves did not prefer to drink crude oil even if it was diluted with water, especially when fresh water was accessible.

It appears doubtful, if cattle would consume a lethal amount of crude oil under natural range and farm conditions.

ACKNOWLEDGMENTS

To Dr. M. J. Twiehaus, Professor and Head of the Department of Pathology, under whose guidance this study was made and for his advice and criticism during the study; to A. M. Wiggins, for his help in administration of the calves, the most heartfelt thanks are extended.

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CRUDE OIL POISONING IN CATTLE

by

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India, 1953

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Pathology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

The purpose of this study was to determine the adverse effects of crude oil in cattle under experimental conditions. The pathological changes were also studied in these same animals.

The crude oil used in this experiment was collected from three different regions in the State of Kansas. Nine healthy Hereford calves of both sexes, eight months to two years of age and weighing from 450 to 650 pounds, were selected for this study. The calves were divided into three groups. Varying quantities of crude oil were administered by means of a stomach tube and pump. Since many workers reported salt poisoning and a high content of salt in oil polluted water, one calf was given salt for a period of four days prior to administration of oil. Salt with oil was then given by means of a stomach tube and pump. In one group of three animals, fresh water was withheld for eight days. During this time one was given oil mixed with water to drink and the other was given crude oil alone by a stomach tube and pump. The third calf was given a choice of fresh water or oil-mixed water to see if it would drink oil-mixed water when fresh water was available. The calves were observed several times daily for any change in condition or toxic symptoms due to crude oil. They were kept under observation for six to ten weeks.

Temperatures were recorded and blood was examined after administration of crude oil and both were found to be within the normal range. The crude oil passed from the rectum the day following administration and continued to do so for several days

thereafter. The animals were found in an intoxicated state following the administration of crude oil. They returned to normal again after several hours. Calves could consume as much as five gallons of crude oil at a time without any ill effect. Calves, receiving smaller amounts in fractional doses for a longer period of time, became ill and eventually died. Autopsy examination of the calves revealed respiratory, digestive and urinary system involvement. Pulmonary involvement and gastro-enteritis were the most conspicuous lesions found. Hemorrhages in the kidneys and urinary bladder with thickening of the wall of the urinary bladder were also observed.

A calf when given preference drank only fresh water and not oil-mixed water. When a calf was given only oil-mixed water, it did not drink for two days, after which it drank only a limited quantity. During the eight-day period it drank only 36 pints of oil-mixed water. It appears doubtful, if cattle would consume a lethal amount of crude oil under natural range and farm conditions.