STUDIES ON POLYTHENE BAG RUMINAL IMPACTION IN SHEEP

BY

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DECLARATION

This is to certify that I carried out the work reported in this thesis in the Department of Veterinary Surgery and Medicine, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria under the supervision of Professors E.O. Gyang, A. N. Ema and O.A Osinowo.

The work of other investigators in the areas covered in this thesis is duly acknowledged and referred to appropriately. No part of this thesis has been submitted elsewhere for a degree or diploma.

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CERTIFICATION

This thesis entitled:"STUDIES ON POLYTHENE BAG RUMINAL IMPACTION IN SHEEP". By Bolanle Dupe Sanni meets the regulations governing the award of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the memory of my late fiancé, AYOTUNDE IBUKUN - OLUWA AWOTOYE (1958 - 1988). May your gentle soul rest in perfect peace - Amen.

"It is fearful thing to love what death can touch." - M.J Worden.

"But" what's lost is nothing to what's found and all the death that ever was set next to life, would scarcely fill a cup." - F. Buechner.

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ABSTRACT

The incidence and course of rumen impaction (RI) with indigestible garbage in sheep with experimentally induced polythene bag (Plastic bag) RI and its effect on weight gain and other clinical parameters was investigated.

Clinic record from the Large Animal unit of Ahmadu Bello University Teaching Hospital (ABUVTH), Zaria revealed that RI constituted 50.2% (117 out of 233) of rumen disorders in small ruminants between 1984 and 1994 and is on the increase. O f the 117 cases of RI 59.8% (70) were in ewes and more frequent in yankasa breed 80.3% (94) than in other breeds. Age distribution of RI in sheep and goats was significantly higher in older animals than younger animals ($P < 0.05$). Of the 15 cases of RI in goats one case was recorded in a male and this was in a West African Dwarf breed while the rest were recorded in female savannah brown goats. RI occurred significantly more in the dry season (November - April) than in the rainy season (May - October). Most complaints presented by clients were swollen abdomen, diarrhea, off feed, gradual weight loss, intermittent abdominal swelling, constipation, grinding of teeth, eating of garbage in pregnant animals or animals that has just lambed. In ewes 58.6% (41 out of 70) cases of RI had a history of lambing or being pregnant. All affected animals were raised under the traditional management system within the township and suburban Zaria. Clinical signs recorded in small ruminants with RI were distended left flank with palpable hard mass, reduced or lack of rumen motility, grinding of teeth, semi solid faeces / diarrhoea, recumbency, dry muzzle, respiratory distress, normal rectal temperature, anorexia and constipation. Clinical diagnosis

were made based on history, clinical exa

necropsy. Treatment of RI cases was by rumenotomy.

In all the twenty - three cases of RI treatment by rumenotomy (18 sheep, 5 goats), polythene bags were recovered. While 6 sheep / 3 goats had ropes and 2 sheep / 2 goats had pieces of cloth in addition. From a pregnant 4 - year - old yankasa ewe, polythene bags interwoven into a single entity was recovered from the rumen, weighting 1.2 kg after washing and drying and measuring up to 90 cm.

A total of 800 small ruminants were slaughtered at Zaria abattoir between November 1994 and January 1995 of which 187 were sheep and 613 were goats. Seventy-seven percent (144 out of 187) of sheep and 20.7% (127 out of 613) of goats were found to have indigestible garbage weighing 0.3 to 2.5 kg in their rumen. Sex and age were found to have a significant ($P < 0.05$) Interaction with RI, occurring more in females and at > 30 months of age. Breed distribution of RI in sheep was significantly ($P < 0.05$) higher in yankasa (81.9%) than in other breeds. Plastic bag was the most prevalent material recovered as observed in 85% of cases. Other materials pieces of cloth and leather, shreds of twine and other ropes woven together into various patterns and mango seeds. Animals with RI had a poor body condition ranging between 0 and 2.

Observations from experimentally induced polythene bag RI revealed that rectal temperature, pulse and respiratory rates were within normal range. Rumen motility (1.5 - 2 per 2 minutes), body condition score (0-3) were significantly lower in sheep with RI. Mean weight changes declined markedly with increase in weight of plastic bag in the rumen and management situation. Weight loss was observed more in animals turned out to grazing

than animals individually intensively m

(T_2 and T_3) animals were in slireds when recovered through a second rumenotomy at the end of the experiment. Haemogram values were observed to be reduced except white blood cell concentration which increased from 8,80 x 10^9 / L in control group (T,) to 9.8 x 10^9 / L and 9.70 x 10^9/ L in T_2 and T_3 respectively. Red blood cell concentration, packed cell volume, haemoglobin concentration, total protein, blood urea nitrogen, serum alkaline phosphates and serum albumin values were significantly low in sheep with RI while mean sodium, potassium, magnesium and chloride values were significantly higher ($P < 0.05$). Rumen pH and bacterial count decreased while protozoa count increased with treatment levels. Plain radiographs did not show clear outline of abdominal organs. While contrasts radiographs taken after a barium meal showed clear outline of the rumen and its content although the contents were not identifiable.

The results of retrospective, clinical and abattoir surveys indicated that RI in small ruminants is very common and it is an important management and environmental problem. The resultant loss of weight, and loss through death or premature culling and high cost of surgical treatment of RI may constitute a major economic loss to small ruminant producers in Nigeria. The live weight of small ruminants may be affected by rumen indigestible garbage giving a false increase of up to 2.5 kg. This study highlights the effect of plastic bags in sheep on various parameters. The decrease or increase of any of these parameters may be used to consider among many other causes of RI indigestible rumen materials. This study strongly suggests the diagnosis of RI using body weight losses of sheep raised on extensive management system. Some recommendations on control of RI in small ruminants were proffered.

TABLE OF CONTENTS

TITLE PAGE i

DECLARATION ii

CERTIFICATION iii

DEDICATION iv

ACKNOWLEDGMENTS v

ABSTRACT vii

TABLE OF CONTENTS x

LIST OF TABLES xi

LIST OF FIGURES xvi

LIST OF PLATES xvii

LIST OF APPENDICES xviii

CHAPTER ONE:

INTRODUCTION 1

CHAPTER TWO :

LITERATURE REVIEW 4

2.1 Introduction 4

2.2 The rumen 4

2.2.1 Gross anatomy 4

2.2.2 Histology 5

2.2.3 Physiology 6

2.3 Nutritionally related rumen disorders 11

2.3.1 Simple indigestion 11

2.3.2 Ruminal parakeratosis 13

2.3.3 Vagus indigestion 14

2.3.4 Ruminal tympany 16

2.3.5 Ruminal impaction 19

2.3.5.1 Pathophysiology 19

2.3.5.2 Clinical signs 21

2.3.5.3 Diagnosis 21

2.3.5.4 Treatment and Prevention 39

CHAPTER THREE :

RETROSPECT, CLINICAL AND ABATTOIR SURVEYS OF GARBAGE RUMEN IMPACTION IN SMALL RUMINANTS 41

3.1 Introduction 41

3.2 Materials and methods 42

3.2.1 Retrospective and clinical surveys 42

3.2.2 Abattoir survey 43

3.2.3 Statistical analysis 43

3.3 Results 44

3.3.1 Retrospective survey 44

3.3.2 Clinical survey 55

3.3.3 Abattoir survey 59

3.4 Discussion 69

3.5 Conclusion 70

CHAPTER FOUR:

STUDIES ON EXPERIMENTAL INDUCED POLYTHENE BAG RUMEN

IMPACTION IN SHEEP 72

4.1 Introduction 72

4.2 Materials and methods 73

4.2.1 Animals 73

4.2.2 Feeding regimen 73

4.2.3 Physical examination 74

4.2.4 Surgery 74

4.2.5 Blood sampling 76

4.2.6 Rumen fluid sampling 77

4.2.7 Radiography 78

4.2.8 Statistical analysis 78

4.3 Results 79

4.3.1 Physical examination 79

4.3.2 Weight change 79

4.3.3 Haemogram and blood chemistry 82

4.3.4 Rumen fluid analysis 86

4.3.5 Radiography 88

4.4 Discussion 91

4.5 Conclusion 94

CHAPTER FIVE:

GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATION 95

REFERENCES 97

APPENDICES 107

LIST OF TABLES

TABLE		PAGE
3:1	Incidence of rumen disorders in small ruminants presented to ABUVTH, Zaria (1984 - 1994).	...45
3:2	Sex distribution of rumen impaction in small ruminants presented to ABUVTH, Zaria (1984 - 1994)	...46
3:3	Breed distribution of rumen impaction in small ruminants presented to ABUVTH, Zaria (1984 - 1994)....	...47
3:4	Age distribution of rumen impaction in small ruminants presented in ABUVTH, Zaria (1984 - 1994)....	...48
3:5	Rumen impaction in small ruminants slaughtered at (SLAB A & B) Zaria abattoir....	...60
3:6	Sex distribution of rumen impaction in sheep slaughtered at (SLAB A &B) Zaria abattoir....	...61
3:7	Breed distribution of rumen impaction in sheep slaughtered at (SLAB A & B) Zaria abattoir....	...61
3:8	Mean body condition score and garbage weight difference in the sexes of small ruminants with rumen impaction....	...62

3:9 Mean body weight, body condition score and garbage weight of abattoir small ruminants with rumen impaction.... 63

3:10 Mean body weight, body condition and garbage weight of abattoir small ruminants with rumen impaction by age.... 64

4:1 The effect of polythene bag rumen impaction in sheep on mean rectal temperature, pulse, respiration and rumen motility.... 80

4:2 The mean weight change in sheep with experimentally induced polythene bag rumen impaction after 42 days of intensive management.... 80

4:3 The mean weight changes in sheep with experimentally induced polythene bag rumen impaction after 42 days of extensive management.... ...81.

4:4 Haemogram and blood chemistry of sheep with polythene bag induced rumen impaction.... 83

4:5 Rumen fluid parameters of sheep with experimental polythene bag rumen impaction.... 87

4:6 Morphologic evaluation of rumen fluid in sheep with polythene bag induced rumen impaction.... 89

4:7 Effect of polythene bag rumen impaction on sheep rumen pH and protozoal numbers.... 90

LIST OF FIGURES

FIGURE		PAGE
3:1	Incidence of rumen disorders of sheep presented to ABUVTH, (1984 - 1994)....	...49
3:2	Incidence of rumen disorders of goats presented to ABUVTH, (1983 - 1994)....	...50
3:3	Seasonal distribution of rumen impaction in sheep and goats presented to ABUVTH, Zaria (1984 - 1994)....	...51
3:4	Indigestible garbage recovered from rumen of small ruminants in ABUVTH, Zaria (1984 - 1994)....	...52
3:5	Age distribution of rumen impaction in sheep and goats slaughtered in Zaria abattoir....	...65
4.1	Body weight changes of sheep with experimentally induced polythene bag rumen impaction	...84

LIST OF PLATES

PLATE		PAGE
I	Sheep seeking food from refuse dump in Zaria....	...53
II	Goats seeking food from refuse dump in Zaria....	...53
III	Polythene bags, the most visible and conspicuous waste in a refuse dump in Zaria....	...54
IV	Polythene bags intertwined swith pieces of ropes removed from rumen of yankasa ewe at ABUVTH, Zaria....	...56
V	A piece of cloth removed from sheep rumen at ABUVTH, Zaria.... ...	...57
VI	A mass of indigestible materials woven into a long strand being removed. through a rumenotomy incision at ABUVTH, Zaria....	...57
VII	The mass of indigestible materials from Plate VI above, washed and dried....	...58
VIII	Polythene bags interwoven into a single entity recovered from a pregnant 4 - year - old yankasa ewe at ABUVTH, Zaria....	...58
IX	A piece of leather removed from sheep rumen from Zaria abattoir.... ...	...66
X	Coarse feed fibre and polythene bags woven into a circle with hard masses along the strand removed from a 5 year-old yankasa ewe from Zaria abattoir ...	...66
XI	A mixture of white (B) and carbon filled grades (C) of polythene bags woven into a strand, removed from a Balami ewe from Zaria abattoir.... ...	...67
XII	Carbon filled grade of polythene bags twisted into a short strand removed from a buck....	...67
XIII	Dry mango seeds from rumen content of a savannah brown buck from Zaria abattoir....	...68
XIV	Interwoven light white polythene (D), shreds of ropes and bags (E), and mango seeds (F) from a 12 - month - old doe from Zaria abattoir.... ...	...68
XV	Polythene bags being placed into the rumen of experimental sheep.... ...	...85
XVI	Polythene bag shreds removed from rumen at second rumenotomy 84 days post insertion....	...85

LIST OF APPENDICES

APPENDIX		PAGE
4:1	Feed intake of Sheep: Hay 3%, Concentrate 1% - Body weight.... ...	...107
4:2	Criteria for body condition scoring	...108
4:3	Materials and methods for determination of haemogram....	...109
4:4	Materials and method for determination of blood urea nitrogen.... ...	...111
4:5	Equipment, reagents and method for determination of serum sodium and potassium value....	...112
4:6	Equipment, reagents and method for determination of serum chloride value....	...113
4:7	Equipment, reagents and method for determination of serum alkaline phosphate value....	...114
4:8	Equipment, reagents and method for determination of serum magnesium value....	...115
4:9	Equipment, reagents and method for determination of serum albumin value....	...116
4.10	Rumen fluid analysis	...117

CHAPTER ONE

1.0 INTRODUCTION

Sheep make a major contribution to world animal production of which large population are found in various third world countries, where they contribute significantly to the economy. For instance, about 50% of the sheep and over 80% of the goats of the world are found in the third world countries. According to FAO (1980) report, the world's population of sheep was 1,130.8 million out of which Africa had 16.3% (FAO, 1980).

In Nigeria, as in most African countries, sheep contribute a significant portion of meat and raw material supply such as skin for the leather industries. Sheep estimated population was 22.1 million in 1990 (FLDPCS, 1991), and they provide about 127 million kilogram of carcass weight annually (Adu and Brinckman, 1981).

Raising sheep is much easier than cattle, requiring less investment in terms of housing, labour and feeding. The efficiency of sheep as converters of feed to meat is much inferior to that of pigs and poultry largely because of their longer generation interval, small litter size and resultant larger overhead for maintenance of breeding stock. However, the non ruminants are in direct competition with man for food while sheep can obtain almost their entire diet from grazing on pasture and farm residue.

Large populations of these animals are raised largely under the traditional extensive system with slight modification in various parts of Nigeria. On the average, 7 small ruminants (3-10) are kept per household, being higher in the northern parts of the country than in the south (Oludimu et al., 1990; Wosu and Ibekwe, 1990).

There has been many reports on the management of small ruminants under the traditional system (Adu et al.,1990; Gefu et al., 1991) and under confinement (Smith et

al.,1987; Otesile et al.,1982;1983). However there has been limited study on their survival within the urban areas (Garba et al., 1994). The desire of more people to keep small ruminants in the populated urban areas posses a feeding problem to the animals. Within the urban area, the main places available for animals to seek out food are refuse dumps. These dumps are full of a great variety of toxic and non-biodegradable materials such as polythene bags, ropes, rubber, leather, glass, cloth, paper, metal, wood, fermented or mouldy food reminants, rat baits, dead rats, and other industrial or factory waste products.

Nutritionally related diseases may result when sheep are forced to eat large quantities of these non-biodegradable materials and indigestible woody fibre as they may become impacted in the rumen.

The clinical diagnosis of rumen impaction is not easy due to inadequate history from clients and inconsistent clinical signs ranging from anorexia, bloat, and ruminal stasis to progressive lethargy and death.

The objective of this study are:

1. To carry out retrospective and clinical surveys of rumen impaction (RI) in sheep and goats
2. To carry out an abattoir survey of RI in sheep and goats
3. To carry out studies on experimentally induced polythene bag RI in sheep. This is with a view of providing information on the clinical signs and other physiological and biochemical changes that will help in early diagnosis and prompt treatment of

naturally acquired cases. The study is also aimed at assessing the role of polythene material rumen impaction on weight gain of sheep.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter deals with the presentation of useful review by previous investigators on nutritionally related rumen disorders in ruminants with respect to etiology, pathophysiology, clinical signs, diagnosis, treatment and prevention. The rumen disorders considered include simple indigestion, ruminal parakeratosis, vagus indigestion, ruminal tympany and ruminal impaction.

2.2 THE RUMEN

2.2.1 Gross Anatomy

The rumen, reticulum and omasum of ruminants are collectively known as the fore stomach. The cardia is located cranio-dorsally in the dome - shaped atrium ventriculi, which is common to both the rumen and reticulum. The sulcus rumino-reticularis (esophageal groove), which extends from the cardia to the omasum is formed by two heavy muscular folds or lips which can close to direct material from the esophagus into the omasum directly, or open and permit the material to enter the rumen and reticulum.

The rumen in the ruminants is a large muscular sac that extends from the diaphragm to the pelvis and almost entirely fills the left side of the abdominal cavity (Frandson and Whitten, 1981) and extends considerably to the right of the median plane ventrally and caudally (Sisson, 1975). The rumen is subdivided into sacs by muscular pillars, which appear from the exterior of the rumen as grooves (Frandson and Whitten, 1981). The dorsal

Calhoun, 1981).

The mucosa is composed of four layers, is devoid of muscularis mucosae but has a submucosa which is loose and blends with the lamina propria. The outer layer stratum corneum varies in thickness from 1 or 2 squamous cells to as many as 10 - 20 cells, while the stratum granulosum consists usually of 1-3 layers of distinctly flattened cells with keratohyalin granules in their cytoplasm. The stratum spinosum consist of 1-10 layers of polyhedral - shaped cells that are slightly larger than the basal cells. The stratum basalis consist of columnar cells located on the basement membrane and have numerous processes. (Stinson and Calhoun, 1981).

According to Dellman(1971),the lamina propria beneath the epithelium consists of a dense felt work of collagen, elastic and reticular fibres and fenestrated capillaries. The submucosa is composed of loose connective tissue, blood vessels and plexuses. The tunica muscularis is composed of the inner circular layer and the outer longitudinal layer. The myenteric plexuses are located between the two layers. Tunica serosa of the rumen is composed of collagen and elastic tissues, is covered by a mesothelium and contains varying amounts of fat, blood and lymph vessels and nerves.

2.2.3 Physiology

The true (glandular) stomach in the ruminant is preceded by three divisions, or diverticula (lined with stratified squamous epithelium), where food is soaked and subjected to digestion by microorganisms before passing through the digestive tract (Frandson and Whitten, 1981).

Fluid flow through the rumen is largely a reflection of salivary secretion rate, since most

of the water drunk or contained in feed is absorbed during maintenance of normal osmotic pressure in the rumen (Kay, 1983). Solid matter is retained in the rumen until it is reduced to a size that will readily pass through the reticulo-omasal crifice and omasum to the lower gut (Kay, 1983). The breakdown of solids is achieved by a combination of chewing during eating, rumination, microbial attack and attrition while being churned by rumen contractions. The more digestible fibrous particles break down quickly and are retained only for a few hours, while the more refractory ones may be retained for days.

As it is progressively broken down, fibrous food may be regarded as cascading through a series of pools, each having definable particle size and retention time, until it is reduced to a size small enough to flow unimpeded to the abomasum (Ellis et al., 1979). In sheep most abomasal particles will pass through a 0.6mm sieve. Most compartments of the gut readily adapt their gross and microscopic anatomy to the nature and quantity of food being eaten (Warner and Flatt, 1965; Fell and Weekes, 1975).

The reticulorumen exhibits two main sequences of contraction; a backward moving (mixing) contraction that is peristaltic in nature, which occurs at approximately one minute interval in domestic ruminants; and a forward moving antiperistaltic (eructation) contraction that occurs about half as frequently (Kay, 1983). The frequency, vigour and completeness of each sequence depends on stimuli generated by the fermenting mass of food in the rumen, so that contractions slow and weaken during the interval between meals.

The mixing contractions tip the fluid ingesta present in the reticulum and cranial sac of the rumen to and fro between the two compartments. The reticulo-omasal orifice relaxes during the second phase of the double reticulum contraction, allowing passage of ingesta into the

omasum. When the diet contains long roughages, fibrous materials tend to be retained in the main compartment of the rumen rinsed through with fluid at each rumen contraction and slowly rotated in opposite directions in the dorsal and ventral sacs (Wyburn, 1980).

Regurgitation during rumination occurs during an extra contraction of the rumen that just precedes a normal mixing sequence. The cardiac orifice relaxes and aspiration of ingester into the lower esophagus is achieved by simultaneous contraction of the abdominal muscles and reduction of thoracic pressure by an inspiratory movement with the glottis closed. Antiperistalsis then carries the bolus to the mouth. Rumination is stimulated by the presence of fibre in the rumen and is reduced in duration when a finely milled diet is given. Even when only fluid is present in the rumen, however a sheep will periodically show a form of rumination, suggesting that the behaviour does not depend wholly on mechanical stimuli from the forestomach (Kay, 1983).

The major feature of ruminant digestion is that microbial digestion or fermentation takes place on a large scale in the rumen and reticulum (Olusanya et al., 1985).

Some important properties that allow microbial digestion of food to occur within the gastro-intestinal tract include: a large capacity of the stomach, a fluid environment with the pH maintained near neutrality (pH of rumen 5.0-7.0), a slow passage of ingesta through the site of fermentation and a continuous removal of the end products of fermentation (Olusanya et al., 1985). Fermentation occurs in the gut in the presence of large numbers of bacteria, protozoa, and fungi which live symbiotically on some of the food that the animal ingests, and the animal in turn derives most of its amino acids by the digestion of these microorganisms (Kay, 1983: Olusanya et al., 1985). All these classes of microbes are required for proper ruminal digestion of nutrients

and optimum rumen health (Russell and Hespell, 1981).

Differences in the digestibility are a main source of the variation between feeds in the efficiency with which they are converted to animal products, but there is little possibility of increasing digestibility through events within the rumen except where there are deficiencies in the supply of nutrients to the rumen microorganisms. The extent and nature of rumen fermentation have a more profound effect on the efficiency and use of digested nutrients. The observed variation in this efficiency may be seen as the limit of the benefits that could come from rumen fermentation (Haresign and Cole, 1981).

Soni and Sharma, (1982) revealed that bacterial and ciliated protozoal count in the rumen fluid increased linearly with increase in dietary concentrate content and peaked at 4 hours post feeding. The numbers of protozoans in rumen fluid have also been found to increase significantly with increasing particle size (Hironaka et al., 1979; Soni and Sharma, 1982). The rumen wall was found to darken in colour with increasing particle size. Also the incidence of rumenitis and abnormal papille significantly decreased as the size of the particles increase (Hironaka et al.,1979). Kay, (1983), reported that if a sheep is given a hay diet that has been ground to a 0.6mm, it flows so rapidly through the rumen that dry matter digestibility is reduced by up to 9% but feed intake may correspondingly increase.

Volatile fatty acids (VFAs) production in the rumen is the result of carbohydrate digestion. The concentrations of VFAs depends on their ratios, composition and the microbial population; acetate, propionate, and butyrate are usually found in a ratio of 65:20:15, respectively (Church, 1969; Olusanya et al., 1985). Valeric, formic and succinic acids are normally produced at low levels within the rumen (Church, 1969). The VFAs and propionate are transported to the

liver uncharged, while butyrate is converted to B-hydroxybutyrate in the rumen wall. B-hyeroxybutyrate also functions as the primary energy source for rumen mucosal cells (Niederman et al., 1990).

The proportions of VFAs produced depends on the type of diet fed to the animal (Olusanya et al., 1985). Propionic acids predominates when the diet contains large quantities of soluble sugars or starch, while ethanoic acid predominates with high dietary roughage. As a result of carbohydrate fermentation, Carbon dioxide (CO_2) and methane (CH_4) gases are produced in a ratio of 60:30 - 40 of the total gas mixture in the rumen. Some nitrogen, oxygen and hydrogen are also produced (Olusanya et al., 1985).

A portion of dietary protein is degraded by the microbes to ammonia, amino acids (Baldwin and Allision, 1983; Olusanya et al., 1985) and CO_2 and short-chain fatty acids (Olusanya et al., 1985). The ammonia may be used as a nitrogen source for microbial amino acid synthesis or may be absorbed directly through the rumen wall. Blood ammonia transported to the liver is converted to urea, which may be recycled back to the rumen via blood and saliva and utilized by rumen microbes as a nitrogen source. Dietary protein that escapes rumen fermentation through the esophageal groove into the abomasum in suckling youngsters or which may be kept operational into adult life (Orskov, 1982) is termed undergraded protein or by pass protein (Kay, 1983). These proteins are available for intestinal digestion and absorption (Kay, 1983).

Most dietary fat consists of either triacyl glycerides, found in seeds and animal fats, or digalactosyl diacyl glycerides found in leaf chloroplast (Kay, 1983) or monoglycerides which are either converted into VFAs or saturated and passed to the small intestine (Baldwin and Allison, 1983). The microbes synthesize some lipid, mainly phosphatide of the cell membrane and

organelles, but this amounts to only about 5 g/day in sheep (Kay, 1983).

2.3 NUTRITIONALLY RELATED RUMEN DISORDERS

Disturbance of the forestomach compartments can result from a variety of disease processes but they all usually give rise to ruminal tympany. These disturbances range from indigestion resulting from dietary abnormalities, inflammatory processes associated with foreign body penetration or abscess formation, neoplasia, trichobezoars (hairballs), and vagal nerve lesions (Dirksen, 1979; Dirksen and Garry, 1987a). The more important ruminal disorders of sheep are highlighted here.

2.3.1 SIMPLE INDIGESTION

Simple indigestion is a common symptomatic diagnosis in the anorexic ruminant with rumen atony (Howard, 1986). The common causes are dietary abnormalities of minor degrees including indigestible roughage, particularly when the protein intake in low. Abnormalities also occur from feeding animals on mouldy, overheated and frosted feeds, or moderate excesses of grain and concentrate (Hoflund, 1967). Sudden management and feeding habits that alter the rumen microflora predispose to the condition (Siegmund, 1991). Indigestion occurs when the normal growth and division cycles of the stable rumen microbial population are disrupted. The changes in the micropopulation in simple indigestion generally cause a more alkaline pH and a decrease in rumen function (Church, 1969).

Clinical signs of simple indigestion include a partially or completely anorexic animal; the rumen is usually full, firm and doughy; the rumen contractions are decreased in frequency,

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ruminants with metabolic alkalosis (Niederman et al., 1990).

2.3.2 Ruminal Parakeratosis

Ruminal parakeratosis is a noninfectious, noncontagious disease of ruminats especially sheep and cattle, characterized by hardening and enlargement of papillae of the rumen (Siegmund, 1991). It has no clinical illness on the affected animals per se but may affect, the rate of weight gains and productivity of the animal (Blood and Radostits, 1989); because there is impairment of metabolism and absorption of short-chain volatile fatty acids by the deeper keratinized layer of rumen epithelium (Stinson and Calhoun, 1981). In sheep, abnormal papillae may be visible and palpable through the wall of the intact rumen. Microscopically, the cornified (keratinized) layer and the Malpighian layer of the epithelium are each far thicker than normal, and the keratinized cells retain vestiges of their nuclei rather than losing their cellular identity in the pink-staining homogeneity which is normally expected (Jones and Hunts, 1983). Whether this is wholly a retardation of a normal maturation, a failure of the aging cells to wear off and disappear, or whether there is also involved a reactive hyperplasia with more rapid production of new epithelium may well be inquired.

The greatest severity of lesions are seen on the dorsal surface of the rumen above the level of the fluid ruminal contents. Fell and Weekes, (1975), thought that the condition is caused by the lowered pH and the increased volatile fatty acid content in the rumen fluid.

The fact that animals feed on unprocessed, whole grain, without developing the disease, suggests that the condition is probably related to the high pH and higher concentration of acetic rather than the presence of longer chain VFAs, in the ruminal fluid (Orskov, 1973). The incidence

of affected animals in an exposed flock may be as high as 40% (Hopkins et al., 1960).

2.3.3. Vagus Indigestion

Lesions which involve the vagus nerve supply to the forestomach and abomasum cause varying degrees of paralysis of the stomach resulting in syndromes characterized by anorexia, abdominal distension, delayed passage of ingesta and the passage of soft pasty feces in small quantities. The disease is common in cattle and has been recorded in sheep (Blood and Radostits, 1989).

In sheep the commonest causes of vagal indigestion are peritonitis, caused by Sarcosporidia and Cysticercus tenuicollis (Naerland and Helle, 1962) and abomasal impaction (Kline et al., 1983), although the exact etiology and pathogenesis of the disease has not been worked out (Kline et al., 1983). The disease has been reproduced experimentally by sectioning the vagus nerve. Hutchins et al., (1957) suggested that naturally occurring lesions may exert their effects by physically impairing stomach movement and interfering with the functions of the esophageal groove, rather than by actual involvement of the vagus nerve. This hypothesis has not been received with enthusiasm by other workers (Neal and Edwards, 1968). Some cases of vagal indigestion have been associated with liver abscesses (Fubini et al., 1985).

The first obvious clinical sign of the disease is moderate to severe ruminal tympany, although the animal is usually emaciated. Inappetence, progressive distension of the abdomen, varying degrees of dehydration and scanty faeces may be observed as the disease progresses (Blood and Radostits, 1989). Temperatures are usually normal but heart rate may be slower (Rebhum et al.,1988). In order to sufficiently describe this condition based on clinical signs three

types of vagal indigestion have been proposed; ruminal distension with hypermotility, ruminal distention with atony and pyloric obstruction and abomasal impaction (Blood and Radostits, 1989). Any combination of the three syndromes may occur but distention of the rumen with atony combined with abomasal obstruction are the most commonly observed sequelae (Pope, 1961).

Ruminal distention with atony may resemble several diseases of the forestomach and abomasum, such as chronic traumatic reticuloperitonitis, abomasal impaction due to ingestion of straw or sand, omasal impaction, phytobezoars blocking the abomasal pylorus and abomasal ulceration without melena. Obstruction of the reticulo-omasal crifice by baling twine, plastic sleeves and bags also may cause distention of the rumen, indistinguishable from vagus indigestion (Zumpt, 1971).

The prognosis in most cases is unpredictable but usually is unfavourable. Rumenotomy and emptying of the rumen is usually followed by slow recovery over a period of 7-10 days when there is hypermotility. The creation of a permanent ruminal fistula to permit the escape of gas in cases where gas retention is a problem may result in dramatic improvement of the animal (Rebhun, 1980).

Some cases respond favourably following fluid and electrolyte therapy for 3 days combined with the oral administration of mineral oil daily for 3 days or dioctyl sodium sulfosuccinate. There have been disappointing results with the use of cathartics, stomach and intestinal lubricating substances (Rebhun et al., 1988). Slaughter of affected animals for meat is recommended as the most satisfactory procedure (Rebhun et al., 1988).

2.3.4 Ruminal Tympany (Tympanites, Bloat)

Ruminal tympany is over distension of the rumen and reticulum with the gases of fermentation, either in the form of a persistent foam mixed with the rumen contents (primary bloat), or in the form of free gas separated from the ingesta (secondary bloat) (Head, 1959; Cohen,1970; and Christian Mills et al., 1970). Bloat occurs in all domestic ruminants, but is most common only in cattle, where it occurs, most frequently in feedlot animals. Sheep, as well as cattle, are susceptible to bloating but , because of their more conservative eating habit, are less commonly involved (Leng and McWilliam, 1973).

Primary ruminal tympany or frothy bloat is by far the more important (Clark and Reid, 1974), and is caused by feeding of finely ground grain which promotes frothiness of rumen content (Hironaka et al., 1973). The poor quality feed does not support the development of normal rumen flora and rumen musculature (Dirksen and Garry, 1987a). Furthermore eructation contractions are weak. As the rumen becomes distended the weak contractions are progressively more ineffective which result in bloat (Dirksen and Garry, 1987a). The viscosity of the ruminal fluid is markedly increased and may be due to the production of insoluble slime by certain species of bacteria which proliferate to large numbers in animals on a high carbohydrate diet (Bartley et al., 1975).

Secondary ruminal tympany or free gas bloat occurs when eructation of rumen gas is decreased, due to obstructions within the caudal esophagus or region of the cardia (Niederman et al., 1990). The obstruction may be caused by a foreign body, by stenosis or by pressure from enlargements outside the esophagus due to carcinoma, granulomatous lesions caused by Actinomyces bovis near the esophageal groove; tetanus particularly in young animals and in

poisoning with Rhizoctonia leguminocola due probably to spasm of esophagal musculature (Hironaka et al., 1973).

Pearson, (1973) reported that bloat was among the four most commonest causes of sudden death in cattle. During one full year, in a colorado feedlot, bloat was the cause of 3% of all mortalities (Jensen et al., 1976). Outbreaks of feedlot bloat are usually of the frothy type while the sporadic cases are of the free - gas type and secondary to lesions which cause dysfunction of eructation (Jensen et al., 1976).Dietary and animal factors influence the occurrence of primary bloat. Primary bloat results when animals are grazed on very succulent pasture, immature rapidly growing legumes in the pre-bloom stage. It also occurs occasionally when the animals are grazed on cereal crops, rape, cabbages, leguminous vegetable crops including peas and beans, and young grass pasture with a high protein content, liberal administration of urea to the pasture, high intake of glucose, calcium, magnesium and a high nitrogen intake (Bartley et al., 1975). Some investigations have shown that cattle can be classified according to their susceptibility to pasture bloat into high or low susceptibility and the offspring show influences of their parentage (Reid, 1975). A number of inherited characteristics have been observed to be related to high incidence of bloat. These include ruminal structure and motility, composition of salivary proteins, rate of salivation, and the ability of the rumen flora to degrade mucoprotein, which would either reduce antifoaming activity or increase foam stabilizing activity. There may also be differences between animals in their ability to breakdown feed in the rumen, and thus the rate of passage of solids out of the rumen.

Diagnosis of bloat is based on the characteristic abdominal distention observed in the upper left flank. However, with time the entire abdomen may become enlarged (Niederman et al., 1990). Cattle usually become bloated soon (within 1 hour) following grazing of bloat-producing pasture, but occasionally there may be a lag period of up to 24-48 hours (Dirksen,

1979). Affected animals are restless, with significant increase in heart and respiratory rates, followed by cardiovascular and respiratory failure that can result in collapse and death. The condition can be very acute and bloat is a common cause of sudden death in ruminants in many parts of the world. Oropharyngeal examination, endoscopy, passage of stomach tube and esophageal radiographs are useful in the diagnosis of secondary bloat (Blood and Radostits, 1989; Niederman et al., 1990). Clinically animals suffering from secondary bloat may make repeated attempts to vomit; there may also be profuse salivation, dyspnea, the visible mucous membrane may become cyanotic, and gait staggering.

Differential diagnosis include tetanus which is manifested by limb rigidity, prolapse of the third eye lid and hyperesthesia. Carcinoma and Papillomata of the esophageal groove and reticulum and actinobacillosis of the reticulum cannot usually be diagnosed antemortem without exploratory laparotomy and rumenotomy.

Therapeutic and nutritional management of bloat is aimed at reducing intraluminal pressure. Passage of a stomach tube is effective in the relief of free-gas bloat. While the tube is in place, antifoaming agent such as vegetable oils, fats, and synthetic non-ionic surfactants can be administered (Wright and Curtis, 1976). The dose rate of non toxic oil such as groundnut oil, corn oil, soyabean oil is about 50 ml for sheep. Emulsified oil and oils containing a detergent such as dioctyl sodium sulfosuccinate is preferred, because they mix better with ruminal contents. Synthetic surfactant (Poloxalene) are also recommended for treatment (Bartley et al., 1975) as well as Cresol, turpentine formaldehyde solution.

Trocarization of the rumen through the left paralumbar fossa is indicated. The cannula is left in place until the animal is relieved of the bloat. This is not recommended in frothy bloat since trapped gas in the foam layer cannot be released. If the animal is in a critical condition or has collapsed, rumenotomy should be performed immediately while the

animal is placed on electrolyte therapy.

Sustained release capsules which act as saponins have been under investigation, in which case a large capsule is administered into the rumen via a flexible large-bore tube. The capsule in the rumen, breaks open exposing an antifoaming agent which diffuses slowly from a matrix of othrylcellulose gel. Treatment is effective for about two weeks, as a prophylactic treatment (Niederman et al., 1990). When fed with grain the built-up antifoaming agent is capable of greatly reducing legume bloat (Niederman et al., 1990).

2.3.5 Ruminal Impaction (Grain overload, D-lactic acidosis, carbohydrate engorgement, Rumen overload).

Ruminal impaction is an acute or chronic disease of ruminants characterized by indigestion, ruminal stasis, dehydration, acidosis, toxemia, incoordination, collapse and frequently, death (Broberg, 1957; Dirksen, 1979; Dunlop, 1972). This may occur as a primary condition or secondary to other conditions such as impaction of other parts of the stomach, traumatic reticuloperitonitis, metabolic disorders, septicemia, confinement and feeding of poor quality hay (Dirksen, 1979; Gyang, 1992). Excessive ingestion of feeds rich in starch or sugars such as cereal, corn, fruits (apples, grape), root crops, bread, bakers dough, sugar beet, mangels, sour wet brewers grain or high-energy prepared feeds can cause primary ruminal impaction (Dunlop, 1972).

Sheep forced to eat large quantities of browse, or are fed fodder trees during drought, may develop rumen impaction (Murray, 1980). Bailing twine, plastic sleeves and bags may also cause impaction of the rumen (Blood and Radostits, 1989).

2.3.5.1 Pathophysiology of Ruminal Impaction

The ingestion of excessive quantities of highly fermentable feeds by the ruminant is

followed by proliferation of gram-positive bacteria, especially Streptococcus in the rumen, whose end-products of fermentation is L- and D - lactic acid, which decreases the rumen pH to 4.5-5.0 and destroys the protozoa, cellulolytic organisms and lactate-utilizing organisms as well as impair rumen mortality (Niederman et al., 1990). Lactobacilli produce lactic acid, which further decreases the pH to approximately 4.0.

The accumulation of lactic acid and resultant low rumen pH cause ruminal stasis and distension, dehydration and systemic acidosis, while high concentrations of volatile fatty acids, tyramine, and histamine inhibit rumen motility at a low pH (Crichlow and Leeh, 1986; Dain et al., 1955). Under experimental conditions, ruminal stasis in sheep can occur, within 8-12 hours of ingestion of adequate grain (Crichlow and Leeh, 1986). Increased dissociated VFA concentrations is believed to be responsible for the reduced reticuloruminal motility and the diarrhoea is considered to be due to the flow of water along the osmotic gradient.

The acid environment of the rumen may cause a rumenitis which leads to ruminal hyperkeratosis which decreases rumen motility (Vestweber and Leipold 1974; Whitlock, 1980). The rumenitis if untreated may lead to liver abscesses, laminitis, peritonitis, ulceration and abscessation of rumen wall and mycotic rumenitis due to secondary bacterial invasion (Whitlock, 1980). Ruminal lactic acid increases rumen fluid osmotic pressure which draws water into the rumen, causing profound rumen distention and systemic dehydration (Colvin and Beckus, 1988). Systemic metabolic acidosis occurs as a result of absorption of both D- and L-Lactic acid. Some of the L-lactate is metabolized to pyruvate by hepatic lactate dehydrogenase. D-Lactate, however, is not metabolized rapidly and it is responsible for most of the systemic acidosis. The plasma bicarbonate buffering system is overwhelmed and fails to neutralize the systemic acidosis. Progressive acidosis and dehydration may lead to the death of the animal in 1-3 days. In protracted cases

overwhelmed and fails to neutralize the systemic acidosis. Progressive acidosis and dehydration may lead to the death of the animal in 1-3 days. In protracted cases hypochloremic alkalosis may follow the acidotic phase (Crichlow and Leeh, 1986).

2.3.5.2 Clinical Signs of Ruminal Impaction

About 8-12 hours After feeding, the animal may develop anorexia, indigestion and irritability (Crichlow and Leeh, 1986). The abdomen is distended and the rumen content is splashy. A yellow-green, sweet smelling, foamy diarrhoea may occur in animals that have ingested excessive feeds. As the disease progresses, atony of the rumen with increase in fluid contents results. Increased pulse and respiratory rates, variable rectal temperature, sunken eyes, loss of dermal elasticity, incoordination, recumbency, collapse, coma, and death may occur in severe cases.

Lal et al., (1989), in a study of experimental acidosis in goats fed on whole wheat, recorded other clinica signs such as constipation, abdominal pain, nasal discharge, head pressing, grinding of teeth, a significant fall in body temperature and ruminal movement and rapid increase in the pulse and respiratory rates. Abdullahi and Muhammed (1981) in a retrospective study of rumen impaction with indigestible garbage in cattle and sheep reported that most of the cases showed signs of simple indigestion which include: anorexia, decreased rumen motility, diarrhea with the faeces sometimes mucoid, grey-green in colour and pasty to loose in consistency, bloating and reduced milk production. Rectal temperatures were within normal range and became subnormal only during terminal stages of the disease. Some of the animals with long standing history of impaction were dehydrated as evidenced by sunken eyes and dry muzzles.

case of large animal abdominal disorder because of the similarity in signs of several abdominal disease. However, the diagnosis of diseases of the digestive tract requires that an accurate history, physical examination and pertinent laboratory data be obtained. Some of the diseases may require laparoscopy, rumenography, telemetric reading or radiography to make a diagnosis and in some cases diagnosis can be established only after exploratory rumenotomy.

(i) History

Diet history and knowledge of previously administered medication by the owner will be important information. Detailed history of pátient on present disease, previous exposure, treatment, and herd or flock management history especially as regards to nutrition are pertinent.

History of ingestion of garbage materials or exposure to environmental factors that can predispose to ingestion of non-biodegradable materials is helpful in diagnosis of ruminal impaction.

(ii) Physical Examination

Observation of the animal often provides the first clue to the nature of the disease (Grymer and Ames, 1981). Visual inspection while standing behind the animal is important for observing abdominal contours.

Palpation and auscultation of the left flank provides reliable information on the degree of fullness of the rumen. Some cases of rumen impaction due to ingestion of garbage have been confirmed through rectal palpation of the rumen in cattle, and external ballotment in sheep and calves (Abdullahi and Muhammed, 1981).

Palpation of rumen content is done by pressing the left flank with the finger tips (Dirksen, 1979). The rumen containing roughage normally feels moderately soft or doughy

in its middle part, and fluctuating in its lower part; and feels tense only at the height of a contraction. Abnormal filling with gas or foam feed mass (bloat) produces taut, elastic tension with a more or less pronounced bulge in the dorsal part of the left flank while overloading of rumen with solid food or soil produces a firmer, barely yielding consistency.

Percussion of the rumen can be carried out with the fingers, using one hand as a plexor and one as pleximeter. A pleximeter hammer or pleximeter disk may be used on the finger but these may produce additional sound (Dirksen, 1979) and can be confusing. Acoustic percussion of the rumen in the left abdominal wall normally produces a subtympanic sound in the dorsal part of the rumen. A completely damped sound is produced when the rumen is overloaded, or contains balls of solid food mass or soil, while a drum - like boom is produced in bloat (Dirksen, 1979).

Ballottement (tactile percussion) is a combination of palpation and percussion in order to obtain information on the consistency and boundaries of organs not accessible by percussion alone (Blood and Radostits, 1989). The technique consists of an interrupted, firm push stroke to push the organ away and allow it to rebound on to the fingertips. Abdullahi et al., (1984) reported that it is quite practical in sheep to feel the presence of foreign bodies in the rumen through the left flank when they are fully relaxed. In their study, most sheep were found to show evidence of fluid and consolidated rolls of garbage in the rumen by the ballottement but it was difficult to detect the presence of polythene materials.

Auscultation of the sounds produced by rumen construction is done by placing a stethoscope with interchangeable 5 cm diameter phonendoscope and rubber bell chest pieces to reduce hair friction sounds, on the hollow of the left flank to assess the nature, strength and frequency of rumen sound. Rumen motility may also be assessed by placing the fist on the hollow of the left flank, and the contraction felt at intervals (Kelly, 1979).

There are usually 1-3 rumen sounds per minute (Kelly, 1979). Rumen sounds are most frequent and strongest, directly after intake of roughage and during rumination; subsequently they become less frequent and weaker. The rumen is in a state of rest after 48 hours of starvation (Dirksen, 1979). Hypermotility occurs during incipient foamy bloat and functional gastric stenosis due to vagus lesion. Hypomotility and atony occurs when there is rumen acidosis, indigestion or traumatic reticuloperitonitis. Functional gastric stenosis is accompanied by a rumbling or bubbling sound. A splashing sound is heard when the rumen is nearly empty or mainly filled with fluid. In many digestive problems rumen motility will be decreased to less than 3 contractions every 2 minutes or completely absent (St. Jean, 1990).

Auscultatory percussion, a process of simultaneously auscultating and percussing the abdomen may be employed for diagnosis of rumen impaction. The presence of a tympanic resonance or "ping" on the left flank is suggestive of rumen or uterine gas, pneumoperitoneum or left displacement of the abomasum (LDA) (Grymer and Ames, 1981; Smith, 1981).

Body temperature taken per rectum with a thermometer, heart rate and respiratory rate determined by auscultation, and pulse rate taken at the femoral artery in the sheep are vital parameters that are indicative of the health status of the animal. In ruminal impaction there is increased pulse and respiratory rates, variable body temperature, and tachycardia (Hoffsis and McGuirk, 1980).

The quantity, consistency, colour and odour of faeces are important. Diarrhoea with a normal odour may indicate simple indigestion or helminthosis (Hoffsis and McGuirk, 1980). Diarrhoea with foul odour may indicate a bacterial infection such as colibacillosis and salmonellosis. A decreased amount of dry faeces is associated with abomasal impaction.

In ruminal impaction, the faeces are usually soft or loose, malodouros and have a grayish colour (Hoffsis and McGuirk, 1980). The presence of undigested feed in the faeces is also suggestive of poor rumen activity (Dirksen and Garry, 1987b).

Colic pain which is continuous, and unrelenting are usually associated with serious cases of rumen impaction. The visceral pain is mediated by the sympathetic nervous system while parietal pain is mediated by the somatic nervous system (Stashak, 1979). Parietal pain tends to render the abdomen "splinted" and external pressure will cause discomfort. The severity of signs of the pain depends on the temperament of the animal.

The skin resiliency test and position of the eye in the orbit are quick ways to estimate the status of total body hydration. Dehydration is associated with sunken eyes and decreased resiliency of the skin and loss of dermal elasticity (St. Jean, 1990).

(iii) Laboratory Data

(a). Rumen fluid Analysis

Examination of rumen fluid was introduced for clinical diagnosis during the 1950's by Hoflund,

Holtenium and Bjorck (Dirken, 1979). Analysis of rumen fluid involves conducting several tests which include: pH determination; colour, consistency, odour evaluation; sediment activity time; reduction - oxidation (redox) potential; titratable acidity and a morphologic assessment of microbes (Alfonso, 1979; Dirksen, 1979).

1. Rumen fluid collection

Several methods of obtaining rumen samples have been described. They vary from samples obtained via stomach tube and rumen fistulae, to those obtained from needle puncture of the rumen cranial to the left flank fold. The former has been found to produce

larger samples (10-50 ml) enough for a complete analysis, whereas the needle puncture technic yields small samples just enough for pH and morphologic studies (Alfonso, 1979). A newer method of aspirating

rumen fluid employs the use of a 2.5 mm catheter attached to syringe and introduced into the rumen via an abdominal puncture (Polack and Perrin, 1990). It is recommended that samples stored at room temperature (20-22^{oc}) be examined within 9 hours of collection, while refrigerated samples (4-5^{oc}) should be examined within 24 hours (Dirksen, 1979).

2. Rumen fluid colour, consistency and odour

The colour of rumen fluid varies with the ration. The colour could be gray and olive to brownish green; pure green in grazing animals, and yellowish - brown in those given maize silage

or straw. Abnormal colours are milky-gray which is associated with rumen acidosis and greenish-black seen in prolonged ruminal stasis (Dirksen, 1979). The consistency of rumen fluid is normally slightly viscous, while a watery rumen fluid signifies inactivity. The presence of bubbles in ruminal fluid is associated with bloat while extremely viscous sample signifies contamination with saliva. The odour is normally aromatic and not repellant, bearing the odour of the particular feed. Abnormal odour include the repulsive, musty, foul odour of protein decomposition, the penetrating acid odour of lactic acid from overeating of readily-digestible carbohydrate, the stale, indifferent odour of inactive rumen fluid and the smell of abomasal contents indicative of pyloric obstruction.

3. Rumen fluid pH

The pH of ruminal fluid is determined using litmus paper (pH range 4 to 8 $\pm$ 0.5), or better, with an electrical pH meter. For accurate pH reading, the rumen sample must not be contaminated with saliva which will falsely elevate the pH.

4. Sediment Activity time (SAT)

Sediment activity test is assessed by placing a sample of the rumen fluid in a glass test tube and recording the time it takes for the fine particles to settle out and the large particles to float to the surface. The SAT in a healthy cattle varies between 4-8 minutes, sedimentation is rapid and floatation is slow in cases of rumen acidosis and stasis (Blood and Radostits, 1989; Niederman et al., 1990).

The redox potential depends on the activity of aerobic microbes in the rumen. The redox potential

is measured by a Potentiometer with platinum - mercuric chloride electrodes. A tension of minus 350-500 (average minus 400)mV has been recorded in the rumen of live sheep by Broberg, 1957 (Dirksen, 1979). The redox dyes used in milk testing can also be used for indirect or crude determination of redox potential (Dirksen, 1979).

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One ml of 0.03% methylene blue solution and 20ml freshly collected rumen fluid at body temperature are mixed in a test tube. The time required for decoloration of the sample is measured, using a plain rumen fluid as a basis for comparison. The test can also be carried out with resazurin or tetrazolium chloride as described by Hofirek 1972 (Dirksen, 1979). One ml of 0.01% resazurin solution is mixed with 20 ml rumen fluid and the time taken for the red colour to disappear is recorded. The time taken is about half that of the

methylene blue dye. The time is shorter for colour change in rumen with acidosis or reduced motality.

6. Morphologic Examination

Morphologic examination of rumen fluid is used to assess the relative numbers and types of protozoa and bacteria present in the sample. The microbial population is sensitive to pH and temperature changes, nutrient availability, and drugs such as antibiotics and Propyleneglycol, within the rumen. Changes in both protozoal and bacterial populations are important in the assessment of rumen health (Niederman et al., 1990).

Protozoa (ciliates and flagellates) in rumen fluid are variable and therefore are only counted on a qualitative basis on a wet mount. There should be 10 moving protozoa per low power field. The density of protozoa is better estimated by placing one drop of rumen fluid on a slide and covered with a cover glass and briefly warmed to about 30^{oc}, by holding over a lighted match and examined at a magnification of x80 or x100 (oil immersion) objective lens of the microscope (Dirksen 1979). The density of the protozoa is estimated as abundant = +++, moderate = ++, few = + none = -, and the ratio of live (motile) to dead protozoa, to assess the rumen health status.

Protozoa in ruminal fluid can be more accurately estimated through the use of counting chamber such as that of Fuchs - Rosenthal (chamber depth 200 mm) or a modified McMaster chamber (Chamber depth 230 mm). The latter method is more suitable. Freshly collected ruminal fluid is mixed by vigorous shaking in a test tube and filtered through gauze. It is then mixed with normal saline in a leukocyte counting pipette in a ratio of 1:5 or 1:10. A few drops of methylene blue solution and 1% formaldehyde solution are added to the mixture and examined under the microscope.

Two major groups of protozoa are recognized within the rumen; holotrichs (ciliate) and entodiniomorphs (flagellates). Holotrichs which are entirely covered by cilia, are more resistant to variations in the rumen environment than the entodiniomorphs, which have cilia located only at the aboral end of the body (Niederman et al., 1990).

Standard bacteriological technics such as direct counting (Breed count) and culture for identification, differentiation and colony counts have so far found no application in the clinical examination of rumen fluid (Dirksen, 1979). Microscopical observation is more useful, and sometimes crucial, for the diagnosis of rumen acidosis, and for this purpose an air - dried smear of rumen fluid is stained by Gram's method (Dirksken, 1979). In addition other staining methods such as iodine, Periodic Acid-Schiff (PAS), Nigrosine, Congo red or Robinow's modified Giemsa stain, and phase contrast microscopy can be applied to fresh or fixed smears of rumen fluid.

The criteria for interpretation of the smear include: the presence or absence of morphological distinguishable bacterial species characteristic of a normal rumen flora, as classified for sheep; the multiplicity, uniformity of forms; and the ratio of Gram - positive (+ve) to Gram negative (-ve) bacteria (Moir and Masson, 1952).

It is difficult to interpret changes in the microscopical appearance on rumen fluid smears, that might be attributable to digestive disorders accompanied by normal or alkaline pH;, although it is possible to exclude the changes brought about by overfeeding with easily digestible carbohydrates (lactic acid fermentation) evident by predominantly Gram-negative bacteria in an acidic pH.. To detect differences in the microscopical picture, it is necessary to make a comparison with rumen fluid from a healthy animal receiving the same ration (Dirksen, 1979).

Provided the pH is within normal range, the Gram -ve bacteria will always be

dominant

(Dirksen, 1979). Higher proportions of Gram -ve bacteria are present with rumen stasis, and Gram +ve bacteria predominates with ruminal acidosis. Ruminants consuming aration with an optimum forage to concentrate ratio (60:40 to 40:60) will have a correct balance of rumen microbes ranging from small Gram -ve cocci, Gram +ve cocci and rods to some chain forming microbes (Niederman et al., 1990). A rich starch diet will produce a more uniform picture with Gram -ve cocci, short and long rods and a relatively high proportion of Gram +ve cocci and rods. Rumen disorder involving ruminal stasis or decomposition may be suspected when the leading bacteria associated with a particular ration are absent, when there is unusual uniformity in the microflora, or when there are bacteria that are not normally present (Dirksen, 1979).

7. Total acidity (titrable acidiy).

Total acidity of rumen fluid is measured in the same way as gastric acidity as described by Jonov, (1958), Slanina and Rossow, (1964). One or two drops of phenolphthalein are added to 10ml of rumen fluid and the mixture is titrated with N/10 NaoH until it becomes flesh - colored. The volume of NaOH required multiplied by 10 gives clinical units of total acidity, which for rumen fluid is normally 8-25 units. It may reach 70 units in hyperacidity as in lactic aci fermentation or reflux of hydrochloric acid from the abomasum.

8. Estimation of Rumen Ammonia Nitrogen

Rumen impaction may tend to reduce the rumen ammonia nitrogen as result of the acidic environment of the rumen which destroys microbial population responsible for protein fermentation.

Measurement of rumen ammonia nitrogen is used to assess microbial fermentation of protein and several methods have been described. Reichardt et al., (1990), reported that

measurements of ammonia after steam distillation of rumen fluid (Markham, 1942) at pH 7.6 were similar to those obtained by microdiffusion. Photometric measurement, using Nessler's reagent, was found to overestimate the ammonia content because of interference by other substances present in rumen fluid.

(b) Haematologic and Biochemical Examination

Examination of blood cells, when correlated with the case history and physical examination, may provide useful information in diagnosis of rumen impaction in cattle, sheep and goats (St. Jean, 1990).

Base line hematological data necessary for clinical interpretation of laboratory results have been reported for Nigerian sheep and goats (Oduye, 1976; Saror and Schilhorn Van Veen, 1977). The determination of hematologic alteration often provide valuable information about the nature of an abdominal disorder (St. Jean, 1990). An elevated PCV and total protein suggest acute dehydration (hemoconcentration) as in acute grain overload, severe profuse diarrhea, intussusception or abomasal volvulus of long duration. For instance experimentally induced rumen impaction in goats given whole wheat directly into the rumen at 80 or 100 g/kg, showed a fall in blood pH, increase in total RBC and WBC counts, Hb, PCV and blood level lactic acid, for the first 12 hours, returning to normal levels and clinical recovery by 72 hours (Lal et al., 1989).

Urea in blood, serum or exalted plasma can be estimated in order to assess the conversion of urea by the action of urease into ammonium carbonate. The solution is treated with Nessler's reagent, and it's extinction is compared with that of Nesslerized ammonium chloride solution of known strength. Nearly all the ammonia in the final test solution is derived from urea (Archer and Robb, 1925).

Hewelt, (1974) observed variations in blood values between and within herds and concluded that variation depended upon the type, quality and intensity of feeding. Blood urea nitrogen were found to be significantly ($P<0.05$) lower in nutritionally stressed sheep (Aganga et al., 1989). It is likely that the blood urea nitrogen of sheep with rumen impaction will also be lowered.

(c) Rumenography

The graphical recording of rumen movements is made with the use of a rumenograph fastened to the left paralumbar fossa by means of a girth passing around the body. A pressure sensor is connected to a pen recorder which draws a pattern (rumenogram) showing frequency, strength and rhythm of movements of the dorsal sac, detected through the abdominal wall (Dirksen, 1979). Rumenograph is a diagnostic tool in evaluating the rumen activity which usually is compromised in rumen impaction where the frequency, strength and rhythm of movement are reduced.

(d) Telemetric Reading

Another way of monitoring rumen activity is by obtaining telemetric reading through insertion of an elastic ballon into the rumen (Dirksen, 1979) or a minature battery-powered radio beacon attached to a stainless steel bolus housing an osmotic pump (Kaith et al., 1985). When the bolus of sufficient size and density to be retained is administered to ruminants the radio signal can be received, using a standard AM broadcast receiver up to a range of 1.5M. A radio telemetering pressure sensitive capsule placed into the rumen via a stomach tube for monitoring rumen activity has also been described by Riley, (1986). The unit will transmit for several weeks and uses an inexpensive, commercially available pressure transducer as a sensor. The telemetric reading will indicate the frequency and depth of rumen motility.

(e) Ultrasonography

The use of ultrasonography to examine the spatial relationship of organs might also be helpful as a diagnostic aid of abdominal diseases (Dirksen and Garry, 1987b). With rumen impaction, the spatial relationship of abdominal organs will be abnormal.

(f) Endoscopy

An endoscope inserted into the paralumbar fossa following production of a moderate pneumoperitoneum has been used for the diagnosis of some digestive tract diseases. A human flexible fibre - optic endoscope inserted through the cannula of an artificial rumen fistula has been used for direct examination of the rumen, reticulum wall and sometimes the reticulo-omasal orifice. The procedure requires dilution of the rumen contents with water (Szekeres and Ven, 1985). Presence of foreign objects in the rumen can be detected through the endoscope.

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(g) Radiography

Abdominal radiography may be required for the diagnosis of abdominal problems in small ruminants and young calves because rectal examination is not practicable. In adults, radiographs are helpful in identification of metalic foreign bodies in the reticulum and for determining reticular penetration of wire into the thorax (Ducharme, 1983). However, in practice there is a dearth of literature on abdominal radiography in large animals especially ruminants. This is probably due to the large compartment of the stomach which are often filled with large quantities of feeds, thus making penetration of x-rays difficult (Ducharme, 1983).

Visualization of the abdominal organs on radiographs depends on a number of factors such as differences in density between one organ and another and the amount of fat present within the abdomen. Emaciated or very young animals with little abdominal fat

present within the abdomen. Emaciated or very young animals with little abdominal fat show poor contrast (Douglas and Williamson, 1971).

Standard views used to study abdominal structures are the right or left lateral views, and standing right and left lateral views. Oblique views, are needed in cases where excessive peritoneal fluid accumulation is suspected.

Contrast radiography along with plain radiographs have been found useful in the evaluation and diagnosis of abdominal disorders. Contrast media such as diatrizoate sodium and barium sulphate ($BaSO_4$) have been used in revealing foreign objects such as rubber, cloth, metals and tumor masses or stenosis of the tract (Douglas and Williamson, 1971; Define and Muniz, 1977). Sharma et al., (1984) used 70% W/V $BaSO_4$, given at a dose of 25-30 ml/kg to obtain abdominal contrast radiographs in 6 adult sheep. The right lateral view was found adequate for visualization of most structures but the typical laminar mucosal pattern of the omasum and spiral mucosal folds of the abomasum were better visualised on the ventrodorsal view. A similar study was also conducted in goats (Kanwar et al., 1983).

Pneumoperitoneography has also been found to be useful in diagnosis of abdominal problems. Air, oxygen, carbon dioxide or nitrous oxide is introduced into the peritoneal cavity to distend the abdomen moderately. This will create a negative radiographic contrast. Carbon dioxide and nitrous oxide have the advantage of being rapidly absorbed from the peritoneal cavity (Lloyd et al., 1989). In impacted rumen the abdominal area occupied by air or other gases introduced will be reduced.

(h) Exploratory Rumenotomy (Celiotomy)

Exploratory rumenotomy permits a thorough check to be conducted on the amount, composition, stratification, degree of contamination, odor and color of rumen content; and assessment of rumen wall. In many conditions it is the only way to establish a

definite diagnosis of ruminal impaction and may also be employed to relieve the condition (Niederman et al., 1990). However, basic criteria that must be used for decision making to carry out rumenotomy must include assessment of history, clinical signs, physical findings and laboratory tests (Ducharme and Lowe, 1988).

Indications of rumenotomy

Rumenotomy is indicated for the removal of penetrating foreign bodies in traumatic reticuloperitonitis (hard ware disease), and relief of impaction or overloading of rumen (Gyang, 1992; Heinze, 1970; Kersjes et al., 1985). It is also indicated in the correction of toxemia associated with ingestion of fetal membrane (Heinze, 1970) or abnormal rumen ingesta such as plastic, rope and toxic plants (Gyang, 1992; Kersjes et al., 1985). It may also be used to reduce rumen bulk as prelude to omasal impaction and correction of abomasal displacement (Gyang, 1992; Niederman et al., 1990)

Restraint, Analgesia and Preparation of Animal.

There is a need to withhold food and water from the animal depending on the nature and expediency of the surgical procedure. Withholding feed for at least 24 hours (Gyang, 1992), maximum of 48 hours (Heinze, 1970) and withholding water for 12 hours prior to surgery will suffice.

The whole left patalumbar area extending from the 10th rib to the tubar coxae and from the dorsum down to the junction of the middle and ventral thirds of the abdomen is shaved, washed and scrubbed with soap, water and disinfectant and cleaned with 70% alcohol. The surgical site is then draped.

The choice of anesthetic technic for abdominal surgery involves many considerations, the most important being the abolition of pain for the patient (Pearson, 1973; Skarda, 1986). Surgery of the alimentary tract in ruminants with few exception, is more

satisfactorily performed with the patient under local or regional analgesia than under general analgesia (St. Jean, 1990). Sedation might be required in wild uncooperative subjects (Wright and New, 1964).

Sheep may be sedated with 0.1ml of 2% roumpon(R) (xylazine) intramuscularly or intravenously. This may be diluted to 0.5ml with sterile physiological saline solution (PSS) before use (Gyang, 1992). Thereafter the animal is restrained on the surgical table on a right lateral recumbency with shaved left flank up with the head slightly elevated.

An inverted "L" block or linear block is used to anesthetize the left paralumber area (Ducharme, 1990; Gyang, 1992). The advantage of the inverted "L" block over line block is that injections are made away from the incision site, minimizing edema and hematoma formation at the surgical site which may interfere with wound healing. However, both techniques produce incomplete analgesia of the peritoneum and increase cost because of large doses of analgesic, and time required (St. Jean, et al., 1987).

Most common hazards associated with general anesthesia of ruminants relate to the interaction of the digestive and respiratory systems (St. Jean, 1990). General anesthesia may permit the regurgitation and inhalation of rumen content, however, it facilitates manipulation of small intestine and traction on the mesentery, and decreases the chance of abdominal contamination (St. Jean, 1990).

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Operative technique

A 6" skin incision 1" caudal and parallel to the last rib and 1.5" ventral to the lumber transverse process is made. The external and internal oblique muscles and transverse muscles are separated along their fibres to minimize bleeding (Hofmeyer, 1988). The peritoneum is then grasped with a thumb forceps and cut with blunt point scissors taking care to avoid damage to the rumen serosa (Heinzé, 1970; Horney and Wallace, 1984).

A sterile obstetrical (OB) glove is then worn over the surgical glove and the peritoneal cavity is explored in the following manner: reticulum and surrounding; diaphragm and ventral esophagus area; spleen; rumen and greater omentum; kidneys and adrenal gland; pelvic area lymphmodes and the inguinal rings; ureters and urinary bladder; intestinal tract and mesenteric lymphnodes; right lobe of the liver and gall bladder, omasum and abomasum; internal genitalia and peritoneal surface in general for the presence of adhesions and tumors (Gyang,1992).

A portion of the dorsal sac of the rumen is grasped and exteriorized through the abdominal incision and stabilized with the aid of forceps, tension (stay) sutures or retractors to minimize spillage of rumen content into the abdominal cavity. Commercially available, self-restraining retractors (Heinze 1970), such as Weingart's apparatus is also used (Kersjes et al., 1985). A rumenotomy wound ring (Ducharme, 1990), sterile gauze packed around the rumen or rubberized shroud (Gyang, 1992) with a rigid, 6" opening (Heinze, 1970), or a polyethene drape (Adamu, 1990) also have been used to prevent contamination of peritoneal cavity in small ruminants.

A vertical incision, approximately 6" long, is made through the rumen wall with a scalpel after which it is discarded. A sufficient quantity of rumen content is removed to permit a thorough examination of the rumen and then the OB glove discarded. Soiled gauze, rumenotomy shroud or stay sutures are removed and surgical site cleaned with warm sterile PSS moistened sponge (Ducharme, 1990).

The rumenotomy incision is closed with continuous double inverting suture pattern such as Connell (Ducharme, 1990), Lembert, or Cushing (Kersjes et al., 1985) sutures, using No 1 or 2 absorbable (Chromic Catgut) or non-absorbable suture (kersjes et al., 1985). Oversuturing the modified cushing suture pattern applied with a straight

needle, is seldom needed or desired (Heinze, 1970). Kumar and Singh (1973), did not notice any appreciable difference between double row of continuous or interrupted Lembert sutures. A thorough peritoneal lavage is done with a suitable antibiotic diluted in PSS.

Abdominal muscles may be closed routinely in 3 or 4 layers, depending on whether the peritoneum is sutured separately or with the transversus muscle. The closure can be made with No 1 or 2 absorbable or non-absorbable suture (Kerjes et al., 1985) using a simple continuous (Heinze, 1970) or simple interrupted suture pattern (Kersjes et al., 1985). If the laparotomy incision is carried out in the lower part of the flank the subcutis, which is more pronounced there, is sutured in a simple continuous pattern with absorbable suture material (Kersjes et al., 1985; Hofmeyer, 1988). Ducharme, (1990) suggest that the abdominal musculature be closed in 2 or 3 layers.

Closure of the skin incision is achieved with a No 2 non-absorbable suture such as silk, nylon, vetafil, using vertical mattress, continuous ford interlocking (blanket) or simple interrupted sutures. It is advocated that any gaping areas in the sutured skin (Heinze, 1970) and the ventral aspect of the skin incision (Ducharme, 1990) should be closed with 2-3 simple interrupted sutures.

Post Operative Management

Antibiotics are administered systemically for 5-7 days because of the degree of contamination that accompanies rumenotomy (Ducharme, 1990). In cases where abscess has been drained at surgery, prolonged administration of antibiotics for 1-2 months is advocated. Penicillin at a dose of 22,000 iu/kg intramuscularly twice a day for 2 weeks and then subcutaneously once a day for 2 weeks (Ducharme, 1990).

Intravenous or oral fluid therapy may be required to correct dehydration or metabolic

alkalosis when present. Rumen transfaunation may be required to restore ruminal flora and stimulate ruminal motility.

Bulky feed should be withheld for about 5 days after surgery. The incision site should be checked daily for abnormal heat, swelling or discharge. A dilute 1% povidone solution or any other suitable disinfectant may be used to flush the incision site. The skin sutures should be removed after 7 (Ducharme, 1990), or 10 to 14 days (Heinze 1970; Gyang, 1992) to minimize wound dehiscence.

Complications of rumenotomy

There is a dearth of literature on surgical complications of rumenotomy in sheep. Kolo and Adamu (1992) in a study on post-surgical complications following rumenotomy in goats in Maiduguri classified complications encountered into immediate and remote. The immediate complication included rise in body temperature, which persists for 2-3 days, peritonitis, reduced or absence of rumen motility and anorexia (Kolo and Adamu, 1992). The remote complication were adhesions between the rumen and abdominal wall observed at post mortem. The adhesions gave rise to chronic indigestion, obstruction of intestine and volvulus in some cases. Ducharme, (1990) also reported incisional infection and swelling which are rarely of serious nature.

Prognosis of rumenotomy

The recovery rate after rumenotomy varies, depending largely upon the time which surgery is undertaken. Accurate prognosis is important in deciding whether surgery should be attempted. Unfortunately, few studies have been done on the prognosis of rumenotomy (St. Jean, 1990).

2.3.5.4 Treatment and Prevention of Ruminal Impaction

Treatment of ruminal impaction depends upon the severity of the case. Mild cases

can be managed by feeding laxative diet (Murray, 1980) using average quality grass hay for several days (Blood and Radostits, 1989). Acute cases require a more aggressive therapy. Therapeutic goals include removal the problem feed source, re-establishing normal circulating volume, establishing normal electrolyte and blood gases and removal of ingested feed. Rumen decompression and lavage, either by rumenotomy or per os through a stomach tube, may be necessary to relieve the ruminal distention and to remove the source of the problem Niederman et al., (1990). Rumen lavage or irrigation involves oral passage of a stomach tube into the rumen. Water is forced into the rumen with a suction pump and the water allowed to flow out due to gravity. This is repeated several times to remove as much of the ingested feed as possible.

CHAPTER THREE

3.0 RETROSPECTIVE, CLINICAL AND ABATTOIR SURVEYS OF GARBAGE RUMEN IMPACTION IN SMALL RUMINANTS

3.1 INTRODUCTION

The small ruminant industry in Nigeria represents a very important national resource, contributing considerably to the national wealth, supply of protein, raw materials for industries and for festive and religious occasions.

Despite the importance of these small ruminants, research efforts to increase the productivity of these species never received desired attention in the early days of livestock research in Nigeria as did the exotic breed (Nuru, 1985). When the limitations of the performance of the introduced exotic breeds in the 1950s and early 1960s became obvious, it became necessary that the genetic potential of the indigenous breeds must be evaluated to enhance their productivity.

The earliest research efforts in the 1970s were in cross breeding of local ewes to improve the indigenous breed of sheep in Nigeria. The research efforts utilized industrial by-products as well as increased production of cereal grains and residues from crops to improve the nutritional level of the animals. This has helped greatly to solve the problems of poor nutrition in semi-intensive and intensive farming systems but with little impact on the extensive system to which a high proportion of our livestock population belong.

Apart from inadequate and unbalanced feeding, high disease prevalence and the associated neonatal mortality rate constitute a major problem to small ruminant production. Contributing factors to sheep and goat production also include low level of literacy among owners and poor methods of animal husbandry. For instance small ruminants raised in rural

households; nomadic and semi-nomadic; and urban households are raised under the extensive husbandry system. These systems lead to low productivity as a result of low levels of nutrition and high exposure to diseases and the ingestion of garbage from the numerous refuse dumps in our cities (Plate I and II).

Earliest reports of rumen impaction with indigestible plastics garbage were by Abdullahi and Muhammed (1981); Abdullahi et al., (1984) and Otesile and Akpokodje (1991).

The condition which was relatively low in the early 1970s is fast becoming a major problem to sheep production due to the widespread use of polythene bags, lack of adequate and proper legislations on waste disposal and inadequate availability of feed for the animals. In the urban areas small ruminants are left to roam and seek their own food. The area available for them are the refuse dumps generated from the careless manners of household and factory waste disposal. A variety of toxic and non-biodegradable, especially synthetic materials abound in such places(Platt III). Ingestion of such materials by the animals result into impaction of the rumen (Otesile and Akpokodje, (1991) and reticulum. The presence of these foreign materials in the rumen and reticulum hampers the absorption of the volatile fatty acids and consequently reduction in the rate of animal fattening. The aim of this study is to assess the incidence rate of rumen impaction in small ruminants raised in Zaria and environ and problems encountered in the diagnosis and treatment of the condition.

3.2 MATERIALS AND METHODS.

3.2.1 RETROSPECTIVE AND CLINICAL SURVEYS

Data on rumen disorders in sheep and goats were collected from case records of

sheep and goats presented to the Large Animal Clinic of Ahmadu Bello University Veterinary Teaching Hospital (ABUVTH), Zaria between January, 1984 and December, 1994. Clinical cases presented to the Large Animal Clinic during the period of this study (1995) were also assessed and used.

3.2.2 ABATTOIR SURVEY

This study was conducted by carrying out an abattoir survey of rumen impaction with indigestible garbage in small ruminants. Daily visits were made to two slaughter slabs at the Zaria abattoir, Kaduna State, to study the prevalence of rumen impaction with indigestible garbage in sheep and goats between November,1994 and January,1995.

At slab A, most of the animals slaughtered are from the urban area of Zaria and such animals were slaughtered and flayed. At slab B, the animals were from villages and they are usually slaughtered and the hairs removed by burning leaving the skin to be cut along with the muscles.

The sex, age, breed, weight, and body condition scores as described by Russel (1978) were recorded. The rumen was also palpated prior to slaughter. After slaughter, the rumen contents were examined, abnormal materials were removed, washed, dried and weighted.

3.2.3 STATISTICAL ANALYSIS

Data was analysed using percentages, chi square and a computer using the software, statistical package - system analytical statistics written by SAS Institute Inc. Cary Nc, U.S.A, analysis of variance (ANOVA) was used to determine the difference in means between each variable under study.

In cases where the they differ, the Duncan's multiple range test was used to identify the individual groups that are different.

3.3 RESULTS

3.3.1 RETROSPECTIVE SURVEY (1984 - 1994)

Clinical records indicate that 233 cases of rumen disorder were presented in sheep and goats between January, 1984 and December, 1994 (Table 3:1). Of the number presented, 193 (82.8%) were sheep and 40 (17.2%) were goats. A total of 117 (50.2%) cases were rumen impaction (RI), 83 (35.6%) were bloat and 33 (14.2%) were simple indigestion.

The number of cases of RI in sheep was significantly higher in 1991 16 (15.7%) and 1993, 14 (13.7%) while in goats it was significantly higher in 1991 and 1994 with 3 cases $P < 0.05$ each (Figure 3:1, 3:2).

Cases of RI in sheep was significantly higher in females (59.8%) than in males (27.3%) $P<0.05$, (Table 3:2).

Breed distribution of RI in sheep was significantly higher in yankasa (80.3%) than in other breeds $P<0.05$, (Table 3:3).

Age distribution of RI in sheep and goats was significantly higher in older animals than younger animals $P<0.05$ (Table 3:4).

Out of the 15 cases of RI in goats one case was recorded in a male and this was in West African Dwarf breed, while the rest were recorded in female savannah brown goats.

RI occurred significantly more in the dry (November - April) season than in the rainy season (May - October) (Figure 3:3).

Most complaints presented by clients were swollen abdomen, diarrhoea, off feed, gradual weight loss, intermittent abdominal swelling, constipation, grinding of teeth, eating of garbage in pregnant animals or animal that has just lambed. In ewes 58.6% (41 out of 70) had a history of lambing or being pregnant. All affected animals were raise under the traditional management system within the township and sub-urban Zaria.

Clinical signs observed in sheep and goats with RI were distended left flank with palpable hard mass, reduced or lack of rumen motility, grinding of teeth, semi solid faeces / diarrhoea, recumbency, dry muzzle, grunting / dyspnoea / hyperpnoea, abdominal breathing, normal rectal temperature, anorexia and constipation.

Clinical diagnosis were made based on history and clinical examination and confirmed by rumenotomy or and at necropsy.

Treatment of RI cases was effected by exploratory rumenotomy to remove all garbage material.

TABLE 3:1 INCIDENCE OF RUMEN DISORDERS IN SMALL RUMINANTS PRESENTED TO ABUVTH, ZARIA (1984 - 1994)

DISEASE CONDITION	SHEEP	GOATS	TOTAL
Rumen impaction	102 (87.2)	15 (12.8)	117 (50.2)
Bloat	63 (75.9)	20 (24.1)	83 (35.6)
Simple indigestion	28 (84.8)	5 (15.2)	33 (14.2)
Total	**193 (82.8)**	**40 (17.2)**	**233 (100.0)**

Key: ABUVTH- Ahmadu Bello University, Veterinary Teaching Hospital.

( ) : - Percentage

TABLE 3:2 SEX DISTRIBUTION OF RUMEN IMPACTION IN SMALL RUMINANTS PRESENTED TO ABUVTH , ZARIA (1984 - 1994)

SPECIES	SEX	FREQUENCY	% FREQUENCY
Ovine	Male	32	27.3
	Female	70	59.8
Caprine	Male	1	0.9
	Female	14	12.0
TOTAL		**177**	**100**

Key: ABUVTH - Ahmadu Bello University, Veterinary Teaching Hospital.

( ) : - Percentage

TABLE 3:3 BREED DISTRIBUTION OF RUMEN IMPACTION, IN SMALL RUMINANTS PRESENTED TO ABUVTH, ZARIA (1984 - 1994)

SPECIES	BREED	FREQUENCY	PERCENTAGE
Ovine	Yankasa	94	80.3
	Uda	4	3.4
	Balami	4	3.4
Caprine	Savannah Brown	14	12.0
	West African	1	0.9
Total		**117**	**100**

Key: ABUVTH - Ahmadu Bello University, Veterinary Teaching Hospital.

( ) : - Percentage

TABLE 3:4 AGE DISTRIBUTION OF RUMEN IMPACTION IN SMALL RUMINANTS PRESENTED TO ABUVTH, ZARIA (1984 - 1994)

SPECIES	AGE (MONTHS)					
	< 12	13 -18	19 - 24	25 - 30	> 30	**Total**
Ovine	5(4.2)	10(8.5)	8(6.8)	32(27.3)	47(40.2)	**102(87)**
Caprine	1(0.9)	3(2.6)	1(0.9)	1(0.9)	9 (7.7)	**15(13)**
Total	**6(5.1)**	**13(11.1)**	**9(7.7)**	**33(28.2)**	**56(47.9)**	**117(100)**

Key: ABUVTH - Ahmadu Bello University, Veterinary Teaching Hospital.

( ) :- Percentage.

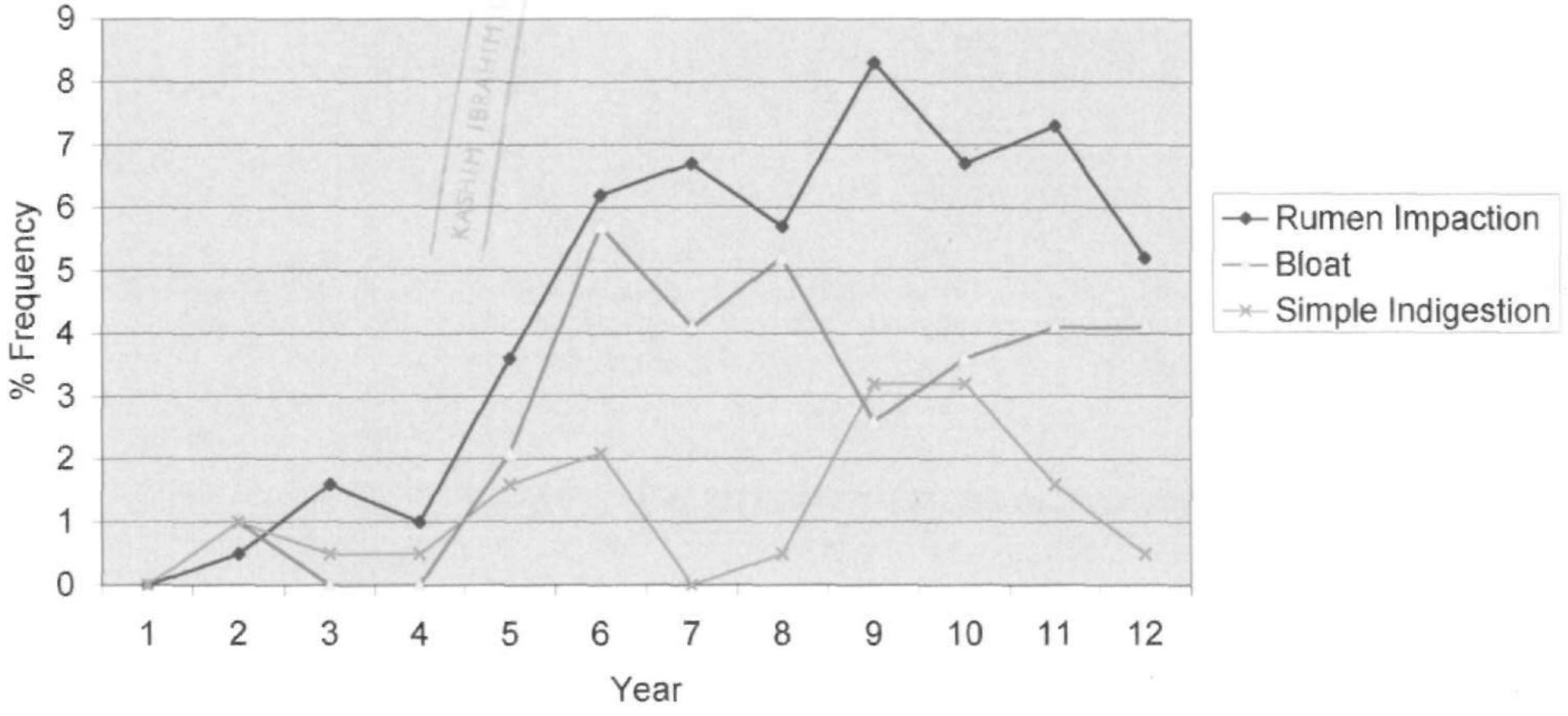


Figure 3:1 Incidence of rumen disorders of sheep presented to Ahmadu Bello University Veterinary Teaching Hospital , Zaria (1984-1994).

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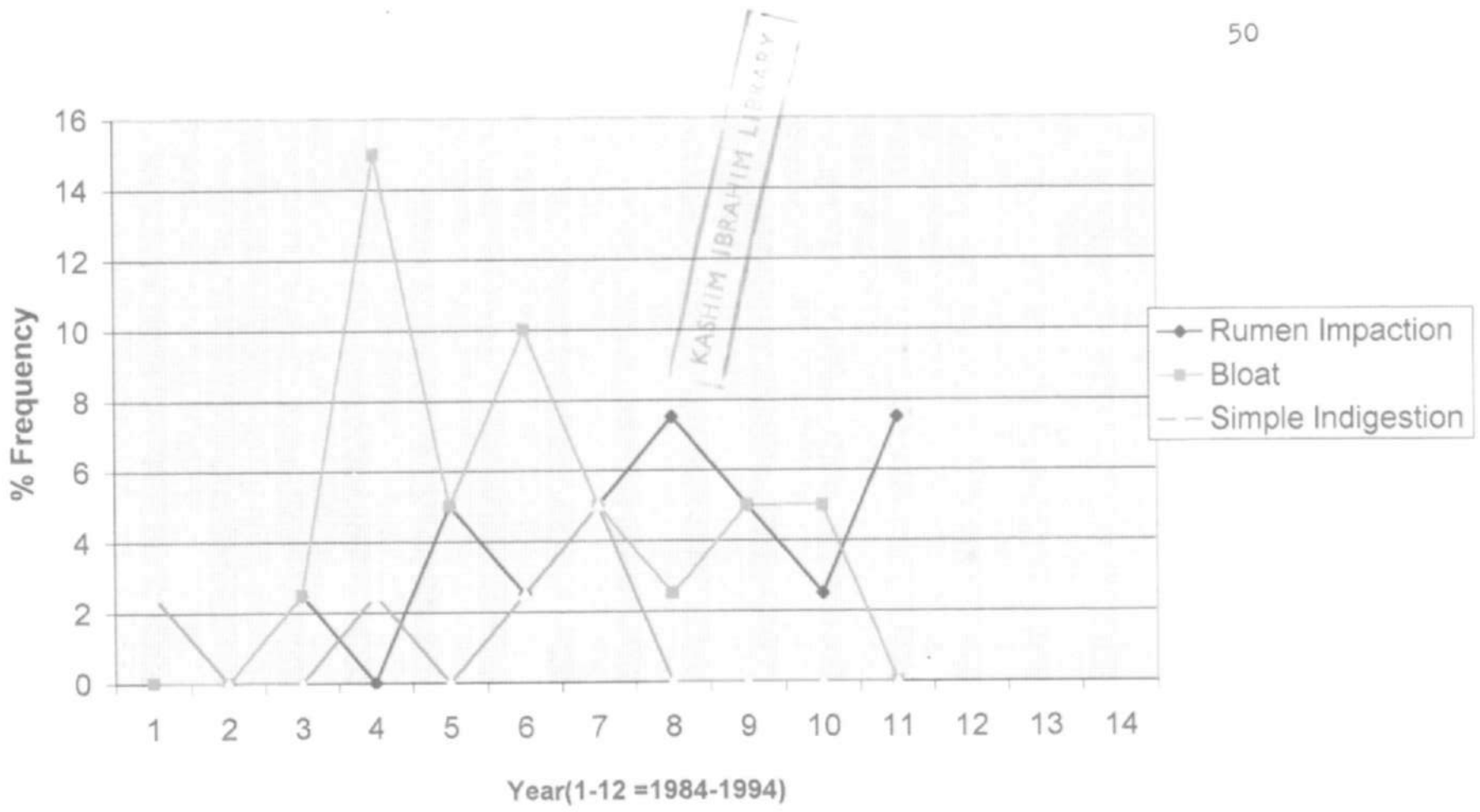


Figure 3:2 Incidence of rumen disorders of goats presented to Ahmadu Bello University Veterinary Teaching Hospital, Zaria. **(1984-1994).**

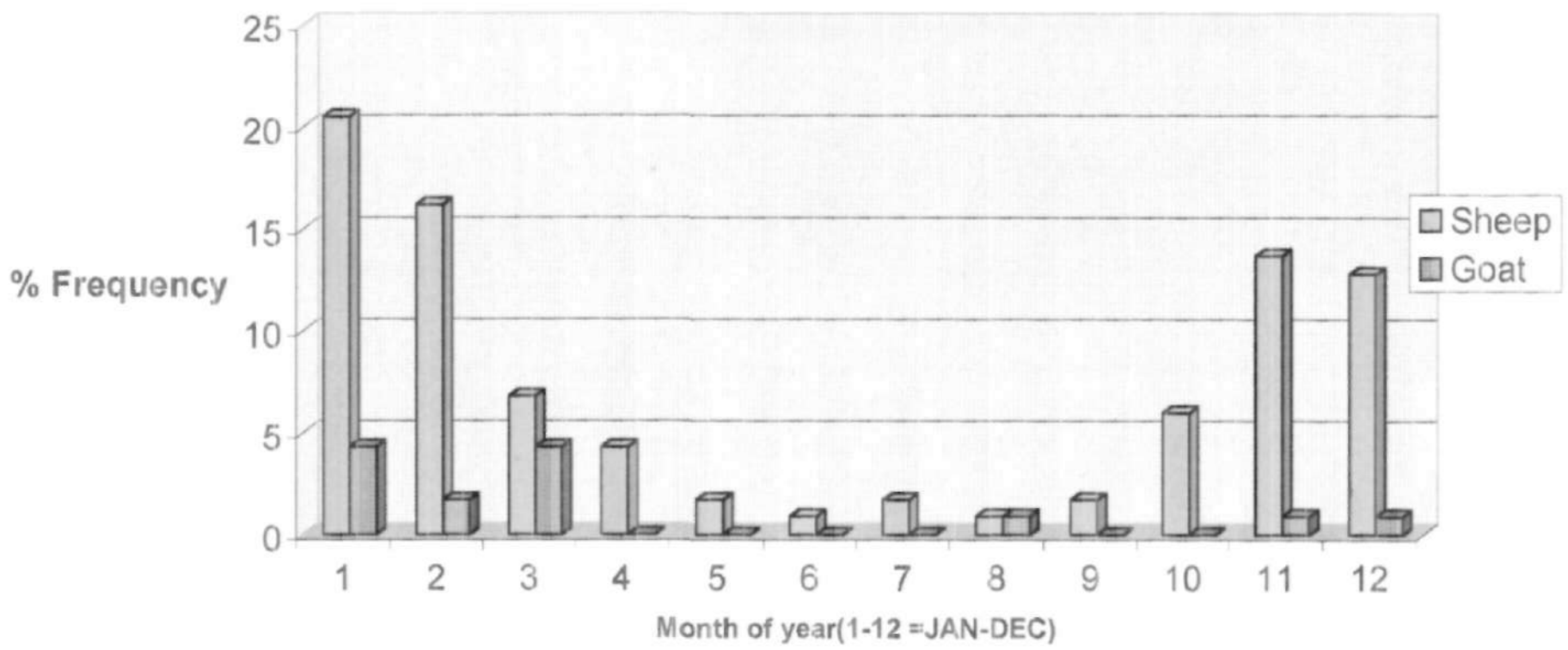


Figure 3:3 Seasonal distribution of rumen impaction in sheep and goats presented to Ahmadu Bello University Veterinary Teaching Hospital,Zaria (1984-1994).

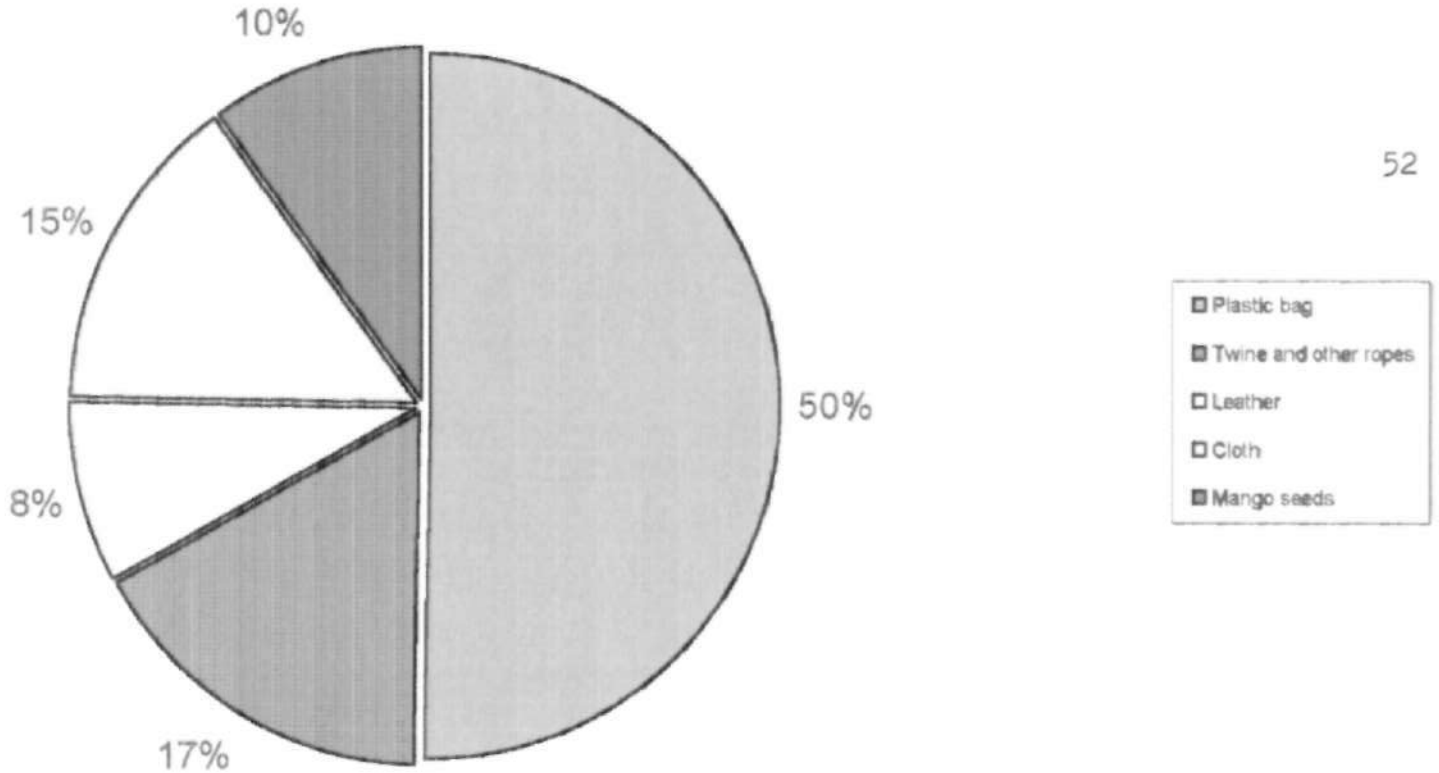


Figure 3:4 Indigestible garbage recovered from rumen of small ruminants in Ahmadu Bello University Veterinary Teaching Hospital, Zaria (1984-1994).



PLATE I: *Sheep seeking food from refuse dump in Zaria.*
(A) Shows an emaciated yankasa ewe



PLATE II: *Goats seeking food from refuse dump in Zaria.*



PLATE III: Polythene bags the most visible and conspicuous waste in a refuse dump in Zaria.

3.3.2 CLINICAL SURVEY (1995)

Clinical survey recorded a total of twenty - three cases of RI which were treated by rumenotomy. Eighteen (78.3%) were sheep and five (21.7%) were goats. All the animals had plastic bags in their rumen while 6 sheep / 3 goats had ropes (Plate IV) and 2 sheep / 2 goats had pieces of cloth in addition (Plate V).

Different garbages (Figure 3:4) were recovered through a rumenotomy incision, washed, dried and weighed (Plate VI and VII). Their weight ranged between 0.6 and 1.2 kg and their lengths between 30 and 90 cm.

From a pregnant 4 - year - old yankasa ewe, polythene bags interwoven into a single entity were recovered from the rumen weighing 1.2 kg after washing and drying and measuring up to 90 scm (Plate VIII).

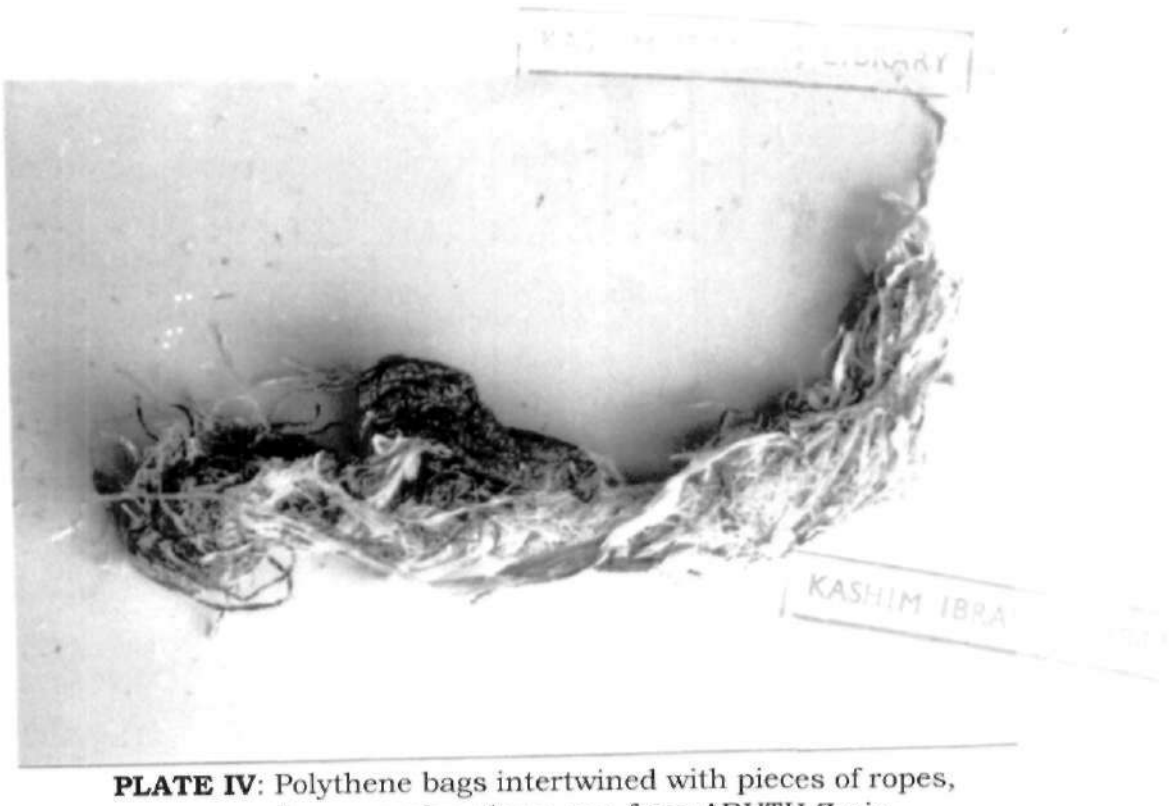


PLATE IV: Polythene bags intertwined with pieces of ropes, removed rumen of yankasa ewe from ABUTH Zaria.

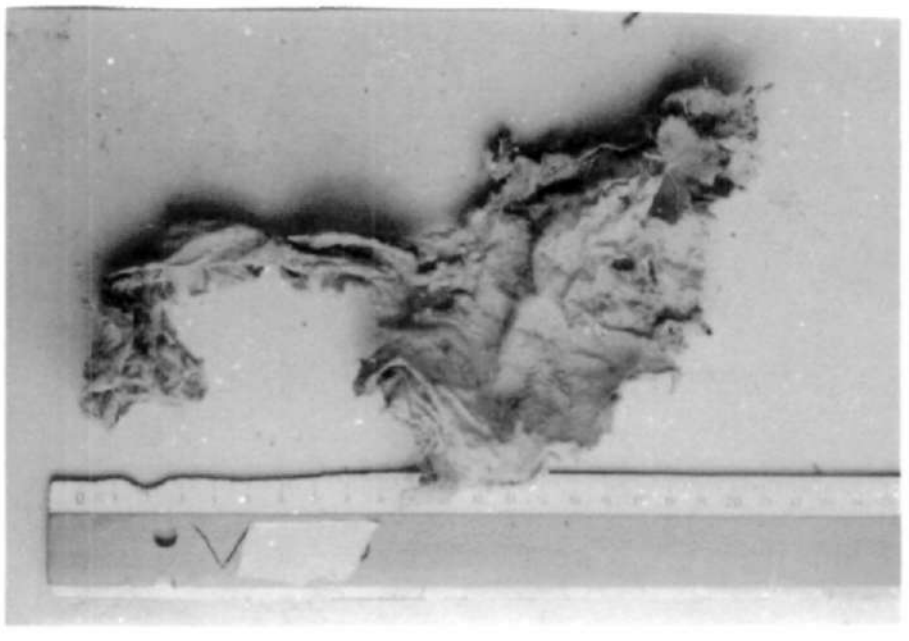


PLATE V: *A piece of cloth removed from sheep rumen at ABUVTH, Zaria*



PLATE VI: *A mass of indigestible materials woven into a long strand being removed through a rumenotomy incision at ABUVTH, Zaria.*

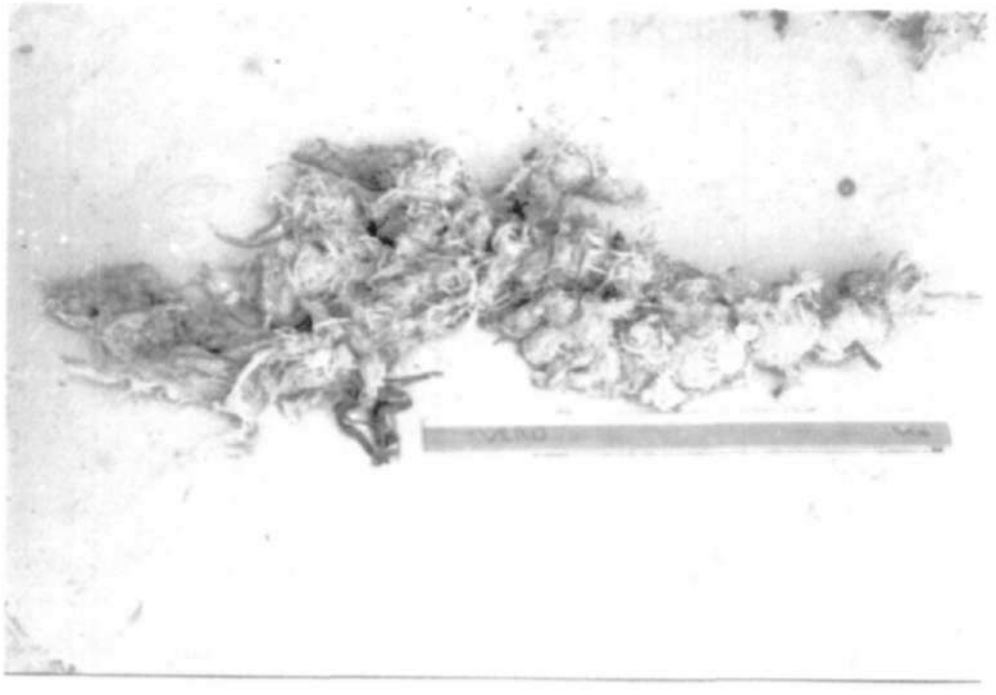


PLATE VII: The mass of indigestible materials from Plate VI above, washed and dreid.



PLATE VIII: Polythene bags interwoven into a single entity recovered from a pregnant 4 year-old Yankasa ewe at ABUVTH, Zaria.

3.3.3 ABATTOIR SURVEY

A total of 800 sheep and goats were slaughtered (Slab A = 440: Slab B = 360). Of which 187 were sheep and 613 were goats. 77.0% (144 out of 187) of sheep and 20.7% (127 out of 613) of goats had indigestible garbage in their rumen (Table 3:5).

Cases of RI in sheep was significantly higher in female (84.0%) than in male (16.0%) $P<0.05$. Similar observation was recorded in goats (Table 3:6).

Breed distribution of RI in sheep was significantly higher in yankasa (81.9%) than in other breeds $P< 0.05$ (Table 3:7).

Age distribution of RI in sheep and goats was significantly higher in older animals than younger animals $P < 0.05$ (Figure 3:5).

The garbage recovered per animal weighed between 0.3 to 2.5 kg with an average of 116 gm. Plastic bag was the most prevalent material recovered as observed in 85% of cases. Other materials include pieces of cloth, leather (Plate IX), shreds of twine and other ropes woven together into various patterns (Plate X, XI, XII) and mango seeds (Plate XIII and XIV).

Body condition score of animals with rumen impaction ranged between 0 and 2 (Table 3:8).

Rumen impaction was found to occur more in sheep and goats slaughtered at slab A with 49.5% (218 out of 440) while only 14.7% (53 out of 360) at slab B. Most of the animals slaughtered at slab A were from the urban area of Zaria, while those slaughtered at slab B were from villages and were found to be younger animals mainly bucks

consisting 97% (350 out of 360) of the total number of small ruminants. Only 35% of RI were diagnosed antemortem through abdominal ballotment and palpation.

The animals slaughtered in slab A had poorer body condition score and more garbage in their rumen (Table 3:9). The weight of garbage recovered was significantly higher in older animals slaughtered in slab A (Table 3:10).

TABLE 3:5 RUMEN IMPACTION IN SMALL RUMINANTS SLAUGHTERED AT ZARIA ABATTOIR. (n = 800)

SPECIES	SLAB A		SLAB B		
	Garbage		Garbage		
	Present	Absent	Present	Absent	**Total**
Sheep	136(17.0)	41(5.1)	8(1.0)	2(3.0)	**187(23.4)**
Goats	82(10.3)	181(22.6)	45(5.6)	305(38.1)	**613(76.6)**
Total	**281(27.3)**	**222(27.7)**	**53 (6.6)**	**307(38.4)**	**800(100)**

Key: ( ) :- Percentage.

TABLE 3:6 SEX DISTRIBUTION OF RUMEN IMPACTION IN SHEEP SLAUGHTERED (SLAB A & B) ZARIA ABATTOIR

SEX	FREQUENCY	PERCENTAGE
Male	23	16.0
Female	121	84.0
Total	**144**	**100**

Key: ABUVTH - Ahmadu Bello University, Veterinary Teaching Hospital.

TABLE 3:7 BREED DISTRIBUTION OF RUMEN IMPACTION IN SHEEP SLAUGHTERED (SLAB A & B) ZARIA ABATTOIR

BREED	FREQUENCY	PERCENTAGE
Yankasa	118	81.9
Uda	21	14.6
Balami	5	3.5
Total	**144**	**100**

Key: ABUVTH - Ahmadu Bello University, Veterinary Teaching Hospital.

TABLE 3:8 MEAN BODY CONDITION SCORE AND GARBAGE WEIGHT DIFFERENCE IN THE SEXES OF SMALL RUMINANTS WITH RUMEN IMPACTION

	SLAB A			SLAB B		
	Male	Female	SE	Male	Female	SE
Total number of animals	115	325		182	178	
Body weight (kg)	15.97[b]	22.07[a]	1.17	18.16[a]	18.37[a]	0.88
Body condition score	1.75[b]	1.98[a]	0.15	2.36[a]	2.05[b]	0.14
Weight of Garbage (gm)	15.35[b]	87.20[a]	2.90	0.675[a]	3.25[a]	2.72

Key:
SE: mean standard error
abc: means bearing different supercript are significantly different (P<0.5).

TABLE 3:9 MEAN BODY WEIGHT, BODY CONDITION SCORE AND GARBAGE WEIGHT OF SMALL RUMINANTS WITH RUMEN IMPACTION

	OVINE			CAPRINE				
SLAB A								
Total No. of animal	153	19	2	182	67	2	4	11
Body weight (kg)	22.02^{b}	32.32^{a}	21.65^{b}	21.65^{b}	19.36^{b}	16.50^{b}	16.77^{b}	19.64^{b}
Body condition score	1.78^{a}	1.74^{a}	1.50^{a}	2.01^{a}	2.09^{a}	2.00^{a}	2.00^{a}	1.82^{a}
Garbage weight (gm)	114.0^{bc}	274.4^{ab}	362.5^{a}	25.0^{c}	18.7^{cb}	105.2^{bc}	81.6^{bc}	35.5^{c}
SLAB B								
Total No. of animals	10	3	0	275	72	0	0	0
Body weight (kg)	18.73^{b}	24.77^{a}	0.00	17.98^{b}	19.8^{b}	0.00	0.00	0.00
Body Condition score	1.16c	3.33	0.00	2.18cb	2.37	0.00	0.00	0.00
Garbage weight (gm)	20.14^{a}	0.00b	0.00	1.81^{b}	0.01	0.00	0.00	0.00

YK = Yankasa
BAL = Balami
KB = Kano brown
WAD = WestAfrica
UD = Uda
SR = Sokoto red
BW = Borno white
CR = Crosses
abc = means bearing different superscript are significantly different ($P < 0.05$).

TABLE 3:10 MEAN BODY WEIGHT BODY CONDITION AND GARBAGE WEIGHT OF SMALL RUMINANTS BY AGE

SLAB	AGE(Months)					
	≤ 12	13-8	19-24	25-30	>30	SE
SLAB A						
Total No. of animals	98	**78**	28	63	173	
Body weight (Kg)	12.67d	18.41c	20.92b	22.68b	24.96a	5.43
Body condition	1.72b	1.88ab	1.75b	2.0ab	2.06a	0.71
Garbage weight (gm)	2.78c	39.87bc	90.61ab	52.61	120.65a	1.00
SLAB B						
Total No. of animals	147	**85**	27	24	77	
Body weight (gm)	16.70b	19.68a	18.411	17.6b	19.83a	4.22
Body condition	2.31ab	2.37a	2.04b	1.67c	2.09ab	0.66
Garbage weight (gm)	0.00b	0.025b	1.28b	4.73ab	7.16a	0.03

SE: *means standard error*

abc, means bearing different superscript are significantly different ($P < 0.05$).

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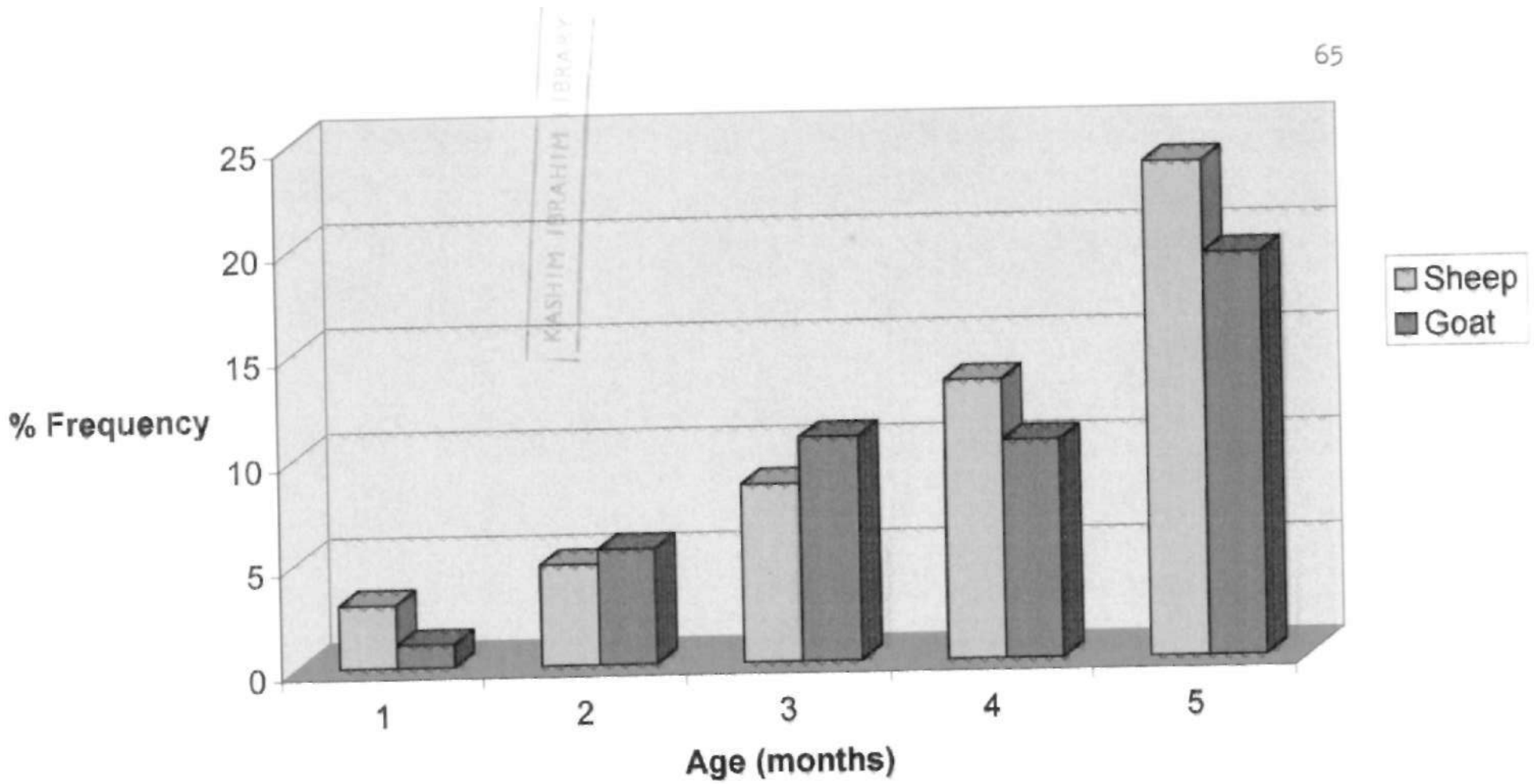


Figure 3:5 Age distribution of rumen impaction in sheep and goats slaughtered in Zaria abattoir.

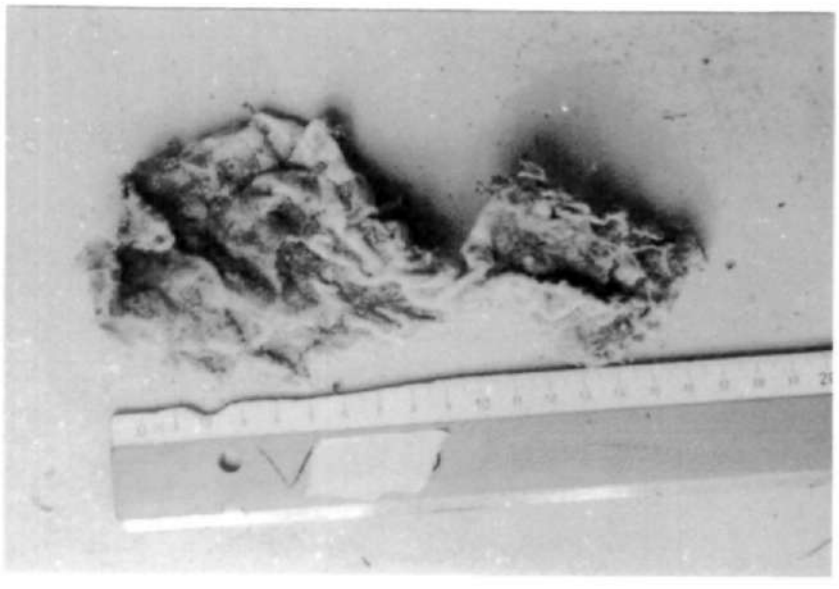


PLATE IX: *A piece of leather removed from* a 5-year old yankasa ewe *from Zaria abattoir.*

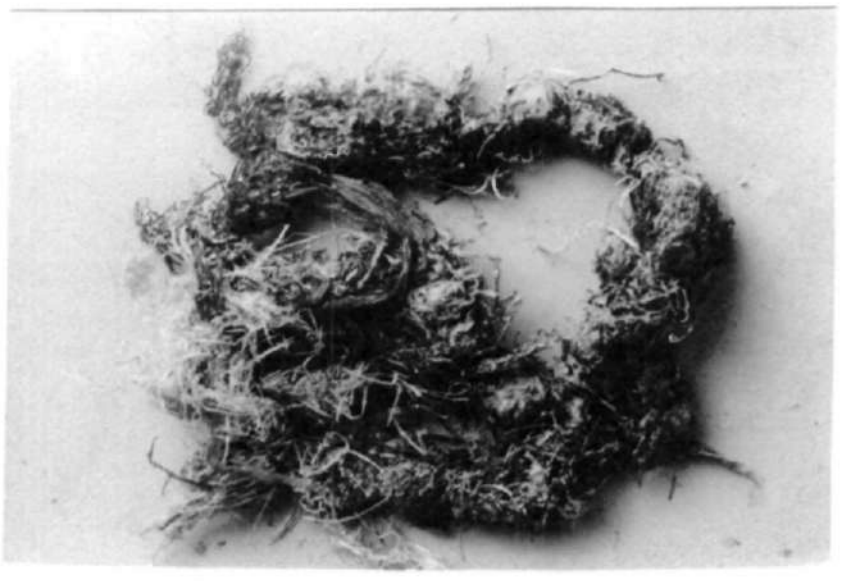


PLATE X: *Coarse feed fibre and polythene bags woven into a circle with hard masses along the strand, removed a 5 year old Yankasa ewe from Zaria abattoir.*



PLATE XI: *A mixture of white (B) and carbon filled grades (C) of polythene bags woven into a strand, removed from a Balami ewe at Zaria abattoir.*



PLATE XII: *Carbon filled grade of polythene bags twisted into a short strand, removed from a buck at Zaria abattoir.*

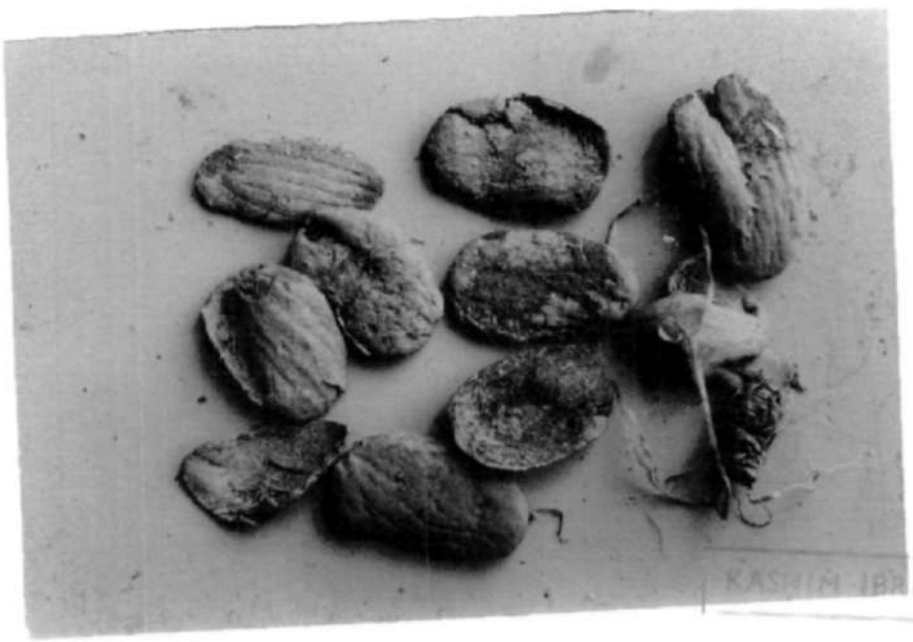


PLATE XIII: *Dry mango seeds from rumen content of a savannah brown buck from Zaria Abattoir.*

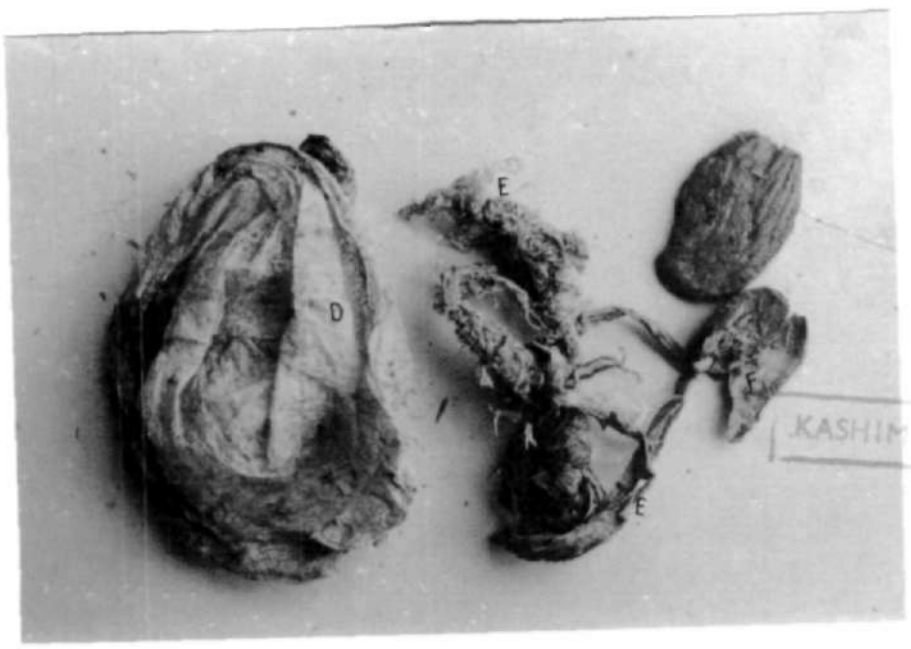


PLATE XIV: *Interwoven light white polythene (D), shreds of ropes and bags (E), and Mango seeds (F) recovered from a 12-month old doe from Zaria Abattoir.*

3.4 DISCUSSION

The incidence of rumen impaction (RI) (50.2%) in this study is high compared with earlier reports obtained by Abdullahi and Muhammed (1981); Garba et al., (1994). These investigators reported an incidence of 40.5% and 48.5% respectively. The reason for this difference is not readily available, however it could be due to increase in use anddisposal of polythene bags in the environment. The animals ae probably attracted by thesmell or taste of the polythene bags because most of the products packed in these bags priorto disposal, are either salty, spicy, sugary or oily, some of which contain some remnant of these products.

More cases were noticed between 1991 and 1994 probably due to an upsurge in the use of polythene bags for packaging and the establishment of several plastic making industries all over Nigeria. These polythene bags are often thrown into rubbish dumps which abound in many urban areas, littering the environment and posing a health hazard to animals raised under the extensive and semi- intensive husbandry system.

The incidence of RI in this study was observed to occur more in the dry season (November - April) than the rainy season (May - October). This observation is similar to that of Abdullahi et al., (1984). This may be because the determinant factors for the ingestion of indigestible materials like polythene bags and other garbage materials are not different from earlier observations. Some of the determinant factors may be scarcity of feed in dry season Murray, 1980) and lack of available grazing areas (Garba et al., 1994).

The significantly higher incidence of RI in females may be due to associated

with hormonal changes during pregnancy (Russel, 1978), especially in ewes carrying twin pregnancy. Another reason could be dueto the gravid uterus which reduce the rumen space by the weight of the foetus hence the weight loss in animal with RI..

The significantly higher occurrence of RI in yankasa breed could be attributed to its larger population in the area of study as reported by the national livestock statistics (FLDPCS, 1991).

The observed difference in age distribution of RI in sheep may be due to the gradual ingestion of indigestible materials which accumulates in the rumen as the animal ages.

The significantlyhigher occurrence of RI in sheep than in goats observed in this study could be due to the highly selective ature of goats while grazing (Murray, 1980). The clinical signs observed in this study are similar to thoseearlier reported by Abdullahi and Muhammed (1981) and Crichlow and Leeh (1986).This similar findings may be a pointer to the presence of RI in small ruminants. The diagnosis of RI has been based on abdominal ballotment which is inconclusive (Abdullahi et al., 1984) because masses of these impacted foreign materials may be mistaken for a foetus during ballotment as observed by Garba et al., (1995).

3.5 CONCLUSION

The results of this surveys indicates that rumen impaction is very common in our small ruminants and it is an important management and environmental problem. The resultant loss of weight, and loss through death or premature culling and high cost

of surgical treatment dueto rumen impaction may constitute a major economic loss to small ruminant producers in Nigeria. The live weight of small ruminants may be affected by rumen indigestible garbage giving a false increase of up to 2.5 kg.

CHAPTER FOUR

4.0 STUDIES ON EXPERIMENTALLY INDUCED POLYTHENE BAG RUMEN IMPACTION IN SHEEP

4.1 INTRODUCTION

Ingestion of a variety of toxic and non-biodegradable synthetic materials by small ruminants have been reported to cause impaction of the rumen and reticulum (Otesile and Akpokodje,1991). Earlier reports of rumen impaction with plastic bags were by Abdullahi and Muhammed (1981). Abdullahi et al., (1984) and Sanni et al., (1995). These authors however observed that inadequate history from stock owners and inconsistent clinical signs probably resulting frosm variations in the nature and consistency of the ingested garbage were constraints to the prompt diagnosis of rumen impaction.

There has been no known controlled study in Nigeria on rumen indigestible materials. This study is therefore designed :

1. To assess the effect of polythene bag rumen impaction in sheep on
   (i) body condition
   (ii) vital parameters (temperature, pulse, respiration)
   (iii) weight
   (iv) haemogram
   (v) blood chemistry
   (vi) rumen content
2. The effect of polythene bags rumen impaction in sheep on the above parameters

in two management systems (intensive and semi-intensive).

4.2. MATERIALS AND METHODS

4.2.1 ANIMALS

Nine adult sheep weighing between 21 and 34 kg were obtained from the flock of National Animal Production and Research Institute (NAPRI), Shika and used for this study .The animals were confined for a period of 2 weeks during which blood and faecal samples were examined for blood and gastrointestinal parasites respectively. The animals were dewormed with Febantel (Rintal$^{(R)}$ granules 10%) at 5 mg/kg body weight orally once a month. Flumethrin (Bayticol$^{(R)}$ 1%) pour on was applied twice a month at 1ml/10 kg body weight to control ticks and Terramycin$^{(R)}$ Long Acting (T.L.A) containing oxytetracycline at 20 mg/kg body weight intramuscularly (i.m) for prophylactic treatment of anaplasmosis and cowdriosis.

4.2.2. FEEDING REGIMEN

In phase I (Day 0 to 48) animals were confined for 48 days, and fed individually with concentrate (maize 100 kg cotton seed cake 100 kg: mineral salt 1 kg) at 1% body weight and hay (Digiteria smutsi) at 3% body weight. In this phase animals were weighed weekly and the feeding levels adjusted based on the new weight (Appendix 4:1).

In phase II (Day 49 to 97) of the study animals were left to graze from 10.00 a.m. to 5.00 p.m. and given concentrate as supplements at 1% body weight daily. In this phase animals were also weighed weekly.

4.2.3 PHYSICAL EXAMINATION

A complete clinical examination of the animals was carried out once a week and for 5 days post surgery. Rectal temperature, pulse rate, respiratory rate and rumen motility rate were recorded. The mucus membrane and hair coat, were examined. Body condition scoring was performed as described by Russel (1978) (Appendix 4:2).

4.2.4 SURGERY

The animals were randomly assigned into 3 groups consisting of 3 animals per group as control, low and high level treatments. These are group T 1, T 2 and T 3 respectively. Thorough physical and laboratory examination was conducted on the animals and their feed was withheld for 24 hours and water for 12 hours prior to the surgery.

Rumenotomy was performed on all the animals. The low level treatment group had 10 pieces (approximately 9.0 g) of Polyethene bags purchased from the market, introduced into their rumen; via the rumenotomy incision. Animals in the high treatment group had 20 pieces(approximately 18.0 g) of polyethene bags. In the control group no polyethene bag was placed in the rumen. The polyethene bags were retrived at the end of the study through a second rumenotomy.

a) Preparation and Anesthesia

The animal's left flank was shaved, scrubbed with soap and water and disinfected with chlorhexidine (Savlon$^{(R)}$). The animals were sedated with 0.1-0.2 ml 2% xylazine (Roumpon$^{(R)}$) intravenously (i.v) and restrained on the surgical table on right lateral recumbency.

Anesthesia was by local infiltration of 5-10 ml 1% xylocaine into the left flank along the proposed site of incision. The area was then dinsinfected with 70% alcohol and draped with four single cotton drapes held to the skin with four towel clamps and covered with a laparotomy sheet.

b) Procedure

An 8-12 cm long verticial skin incision was made in the left paralumbar fossa, starting about 5cm ventral to the lumbar transverse process and 2-5 cm caudal to the last rib. The incision was taken through the external oblique muscle. The internal oblique and transversus abdominis muscles were separated vertically along their fibres. Then the transversalis fascia and peritoneum were elevated with a thumb forceps and incised with a scalpel, to expose the rumen immediately below. The peritoneal cavity was then examined routinely.

The rumen was exteriorized and four stay sutures applied at 3,6,9 and 12 o'clock respectively into the rumen and skin. The rumen was incised and the surgeon wore an OB glove over the surgical glove and explored the rumen for presence of any indigestible material such as polythene bags. Such materials were removed. The OB glove was discarded. soiled drapes were also removed, surgical site was cleaned with sterile PSS moistened gauze and clean drapes were put in place.

The rumen incision edges were held up with the aid of two Allis tissue forceps. The polythene bags were then individually, with the aid of a long thumb forceps placed into the ruminal lumen of the animals in group 2 and 3.

The rumen beginning dorsally was closed with No. 2 chromic catgut using two rows of cushing sutures, and replaced into the abdomen. Oxytetracycline in sterile Physiological Saline Solution (PSS) was used as peritoneal lavage.

The peritoneum and muscle layers were closed with simple continuous suture pattern, using No 2 chromic catgut. The skin incision was closed with interlocking sutures using No. 2 silk.

c) Post Operative Care

Feed was withheld from animals after surgery till the next day but water has provided. Animals were given Combiotic(R) (200,000 units Procaine Penicillin G and 0.25 g dihydrostreptomycin sulfate per ml) intramuscularly (i.m) at a dosage of 1 ml/10 kg body weight for 5 days. Cooper healing oil (McDongall and Robertson Ltd, England), was applied on Skin incision daily until Sutures were removed 10 days after surgery.

4.2.5 BLOOD SAMPLING

Ten mls of blood was collected via jugular venipuncture from each animal into 2 sterile bottles contining Dipotassium salts of ethylene diaminetetraacetate acid (EDTA), 2 ml of blood in each bottle, and the remaining 6 ml into a sterile test tube without EDTA to obtain serum. These samples were obtained once a week throughout the period of study. Samples were also obtained on the day of surgery and two subsequent days.

a.) Haemogram

Total white blood cell (WBC), total red blood cell (RBC), packed cell volume, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) total plasma protein and differential WBC count were carried out using the method described by Coles (1986) (Appendix 4:3).

b.) Estimation of blood urea nitrogen concentration.

Blood urea nitrogen concentration was determined using the method described by Archer

and Robb (1925) (Appendix 4:4)

c.) Blood chemistry

Determination of blood sodium and potassium were determined using the flame photometry described by Wolf et al., (1972) (Appendix 4:5). Chloride value was determined by the method described by Schales and Schales (1942) (Appendix 4:6). Alkaline phosphate value was determined using the photoelectric colorimeter described by Bessey et al., (1946) (Appendix 4:7). Magnesium value was determined using an atomic absorption spectrometer as described by Wolf et al., (1972) (Appendix4:8). Albumin value was determined by the method outlined by Wolf et al., (1972), using a spectrometer (Appendix 4:9).

4.2.6 RUMEN FLUID SAMPLING

Rumen fluid were obtained at surgery before rumen impaction and after removal of polythene. Rumen fluids were also obtained twice during each phase of the study. The samples were analysed based on colour, consistency, flotation and sedimentation time, pH, ammonia nitrogen concentration, redox potential, total acidity and bacterial and protozoa count.

a.) Rumen Fluid Collection

The fluid was recovered through a stomach tube attached to a suction pump on the outside and a stainless steel strainer on the inside. The stainless steel strainer end was inserted into the rumen through the rumen incision during surgery or through the mouth into the rumen. About 50 ml of rumen fluid was collected into a sterile plastic bottle. Another 10 ml of rumen fluid into a sterile plastic bottle containing equal amount of 1% H_2SO_4; for rumen ammonia nitrogen determination.

b.) Rumen Fluid Analysis (Appendix 4:10)

Rumen fluid in a test tube was observed for colour, consistency and odour (Dirksen, 1979). Rumen fluid pH was determined immediately after collection by using an electric pH meter. Sedimentation activity time (Dirksen, 1979) redox potential (Broberg, 1957) and total acidity (Slanina and Rossow 1964), were determined. Morphologic examination to assess bacterial and protozoal count and type were also carried out by the methods described by Moir and Masson (1952) and Dirksen (1979). Rumen ammonia nitrogen was determined by a steam distillation unit as described by Markham (1942).

4.2.7 RADIOGRAPHY

Plain and contrast radiographs of the abdomen were taken before and after rumen impaction with polythene bags. The standard left lateral views were taken. The constrast medium used was 70% w/v barium sulphate given at a dose of 30 ml / kg via a stomach tube (Sharma et al., 1984). The animal were fasted of food for 24 hours and of water for 12 hours prior to administration of the barium meal.

4.2.8 STATISTICAL ANALYSIS

Data obtained were subjected to analysis with the aid of a computer using the software, statistical package - system analytical statistics written by SAS Institute inc. Cary NC, U.S.A. Analysis of variance was used to determine the difference in means

between each variable under study. In cares where they differ, the Duncan's multiple range test was used to identify the individual groups that are different.

4.3 RESULTS

4.3.1 Physical Examination

Rectal temperature, pulse and respiratory rates were within normal range in the control group (T 1), low treatment (T 2) and high treatment (T 3) groups (Table 4:1). Mean rectal temperature (T^{oc}) were 38.5, 38.7 and 38.8 in T 1, T 2, and T 3 respectively . Pulse rates (beats / minute) were 86, 82 and 85 in T 1, T 2 and T 3 respectively. Respiratory rate (cycles / minute) were 24, 20 and 25 in T 1 T 2 and T 3 respectively.

Table 4:1 shows the values of rumen motility and body condition score for sheep with rumen impaction (RI) . Rumen motility (cycles / 2 minutes) was normal in T 1, which was 4 cycles / 2 minutes, while T 2, and T 3 recorded lower rates (2 and 1.5 cycles 2 minutes respectively). Mean body condition score in T 1 group was 4. Animals in T 2 and T 3 groups had a poorer body condition score of 3.

4.3.2 Weight change

Table 4:2 and 4:3 show mean weight change in animals which were individually fed (phaseI) and during grazing (phase II) respectively. Mean weight changes declined markedly with increase in weight of plastic bags introduced into the rumen.

In phase I treatment, feed intake of animals in control group (T 1) was higher than T 2 and T 3 (0.97, 0.89 and 0.79 kg /day respectively). Only animals in T 1, group had a

TABLE 4:1 THE EFFECT OF POLYTHENE BAG RUMEN IMPACTION IN SHEEP ON MEAN RECTAL TEMPERATURE, PULSE, RESPIRATION AND RUMEN MOTILITY

TREATMENTS	1	2	3	SE
Rectal temperature(°C)	38.5	38.7	38.8	0.12
Pulse beat / min	86	82	85	0.25
Rumen motility / 2min	4	2	1.5	0.01
Respiratory cycle / min	24	20	25	0.15
Body condition score	4	3	3	0.35

Key:
SE: Standard Error
T1: Control (No polythene bag in rumen)
T2: Low treatment (10 pieces - 0.9 g of polythene bag in rumen)
T3: High treatment (20 pieces - 18.0 g of polythene bag in rumen)

TABLE: 4:2 THE MEAN WEIGHT CHANGE IN SHEEP WITH EXPERIMENTALLY INDUCED POLYTHENE BAG RUMEN IMPACTION AFTER 42 DAYS OF INTENSIVE MANAGEMENT

TREATMENT	T1	T2	T3	SE
Initial weight (kg)	26.83	26.70	33.00	0.28
Final weight (kg)	28.70	25.33	30.76	0.53
Live weight gain (g)	44.52	-32.62	-53.33	1.44
Feed intake (kg/day)	0.97	0.89	0.79	0.01
Feed conversion (kg feed / gain)	21.78	-27.28	-14.81	0.43

The difference between the treatment and control groups were significant ($P < 0.01$)

Key:
SE: Standard Error
T1: Control (No polythene bag in rumen)
T2: Low treatment (10 pieces - 0.9 g of polythene bag in rumen)
T3: High treatment (20 pieces - 18.0 g of polythene bag in rumen)

TABLE 4:3 THE MEAN WEIGHT CHANGES IN SHEEP WITH EXPERIMENTALLY INDUCED POLYTHENE BAG RUMEN IMPACTION AFTER 42 DAYS OF SEMI INTENSIVE MANAGEMENT

TREATMENT	T1	T2	T3	SE
Initial weight	26.83	26.70	33.0	0.28
Final weight	31.65	24.80	28.83	0.37
Live weight gain	4.82	-1.90	- 4.17	0.17

The difference between the treatment and control groups were significant ($P < 0.01$)

Key:
SE: Standard Error
T1: Control (No polythene bag in rumen)
T2: Low treatment (10 pieces - 0.9 g of polythene bag in rumen)
T3: High treatment (20 pieces - 18.0 g of polythene bag in rumen)

live weight gain of 44.52 g while T 2 and T 3 groups lost weight (- 32.62 g and - 53.33 g respectively).

Management situation was found to affect weight change. Weight loss was observed more in animals turned out to grazing (phase II) than animals individually intensively managed (phase I) (Fgure 4:1). Intact plastic bags placed in rumen of T 2 and T 3 animals (Plate XV) were in shreds when recovered through a second rumenotomy at the end of phase II treatment (Plate XVI).

4.3.3 Haemogram and Blood Chemistry:

Table 4:4 shows the value of haemogram and blood chemistry on treatments

i) Haemogram

Haemogram value were observed to be reduced except white blood cell concentration which increased from 8.80 x 10^9/l in control group to 9.80 x 10^9/l and 9.70 x 10^9 /l in T 2 and T3 respectively.

ii.) Blood Urea Nitrogen

The presencse of plastic bag in the rumen significantly ($p<0.05$) decreased the blood urea nitrogen. The values were 10.35 mg/dl in the T 1 and 8.76, 8.56 mg / dl in the T 2 and T 3 groups respectively.

iii.) Electrolytes

Mean serum sodium, potassium, chloride, alkaline phosphate, magnesium and albumin were significantly higher in the control than treatment groups as follow: Serum sodium (mEq / l) for T 1 was 148.62 while it was 146.10 and 145.70 in T 2 and T 3

TABLE 4:4 HAEMOGRAM AND BLOOD OF CHEMISTRY OF SHEEP WITH *POLYTHENE BAG INDUCED RUMEN IMPACTION*

TREATMENT	1	2	3	SE
RBC (10^{12}/L)	9.50^a	7.54^b	6.45^c	0.32
PCV (%)	38.80^a	28.30^b	27.21^c	0.04
Hb (g/dL)	11.68^a	9.08^b	7.63^c	0.03
MCH (Pg)	11.14^a	9.70^b	8.58^c	0.60
MCV(Femtoliters)	32.03^a	28.54^b	27.16^c	0.20
WBC (10^9/1)	8.80^a	9.80^b	9.70^b	0.14
MCHC (g/d1)	34.21	33.88	32.41	0.29
Alkaline phosphate (u/1)	67.20^a	45.90^b	42.00^b	0.96
Blood urea nitrogen (mg/dL)	10.35^a	8.76^b	8.56^b	0.32
Total protein (g/dL)	6.50^a	5.67^b	5.18^b	0.06
Serum albumin (g/dL)	3.61^a	2.87^b	2.66^c	0.04
Serum sodium (mEq/L)	148.62^a	146.10^b	145.70^c	0.45
Serum potassium (mEq/L)	4.86^a	4.67^b	4.44^c	0.13
Serum magnessium (mg/L)	2.88^a	2.09^b	2.81^c	0.02
Serum chloride (mEq/L)	107.52^a	104.74^b	106.52^b	0.44

Key :

abc: means bearing different superscript on the same row are significantly different ($P < 0.05$)
SE: Standard Error
T1: Control (No polythene bag in rumen)
T2: Low treatment (10 pieces - 0.9g of polythene bag in rumen)
T3: High treatment (20 pieces - 18.0g of polythene bag in rumen)

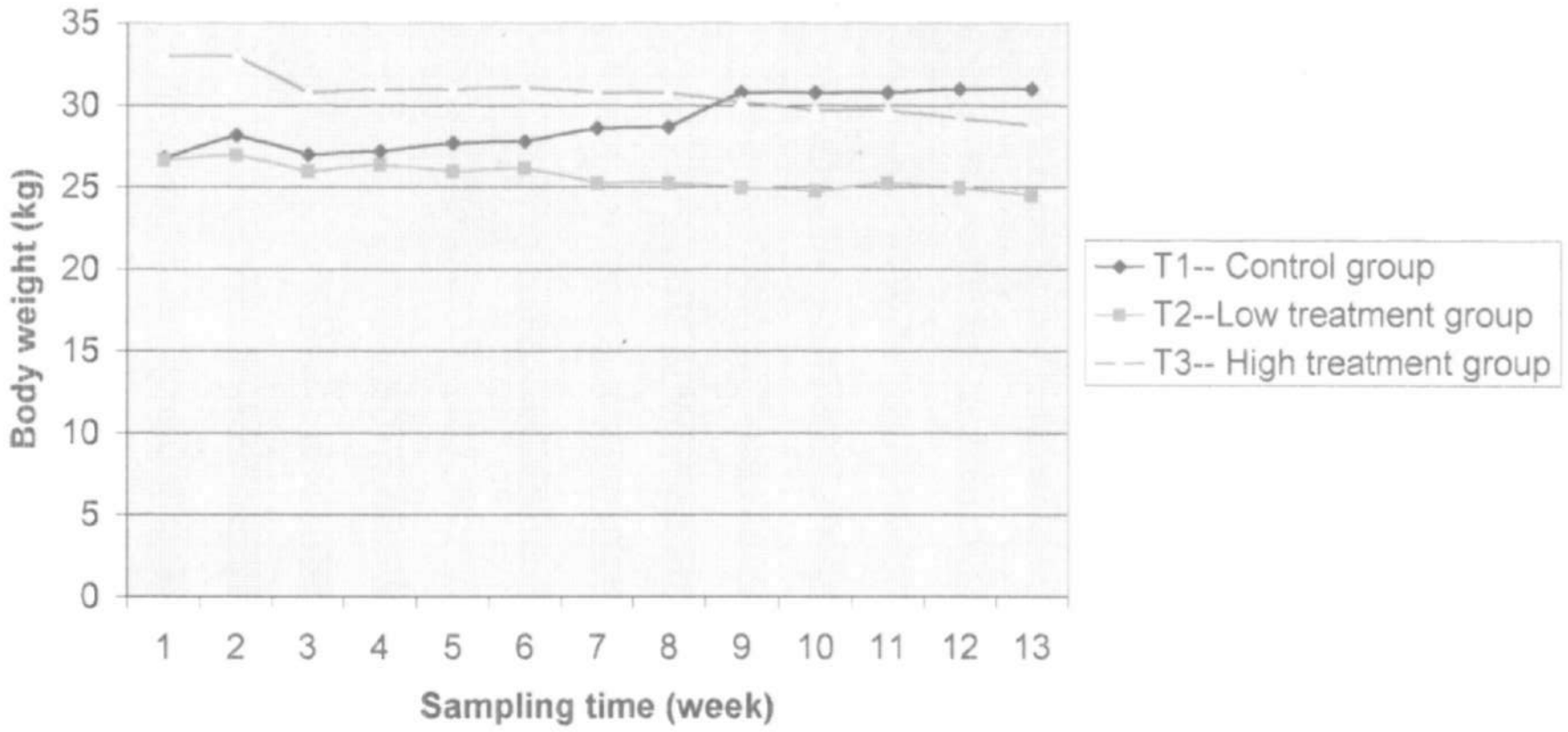


Figure 4:1 Body weight changes of sheep with experimentally induced polythene bag rumen imapaction

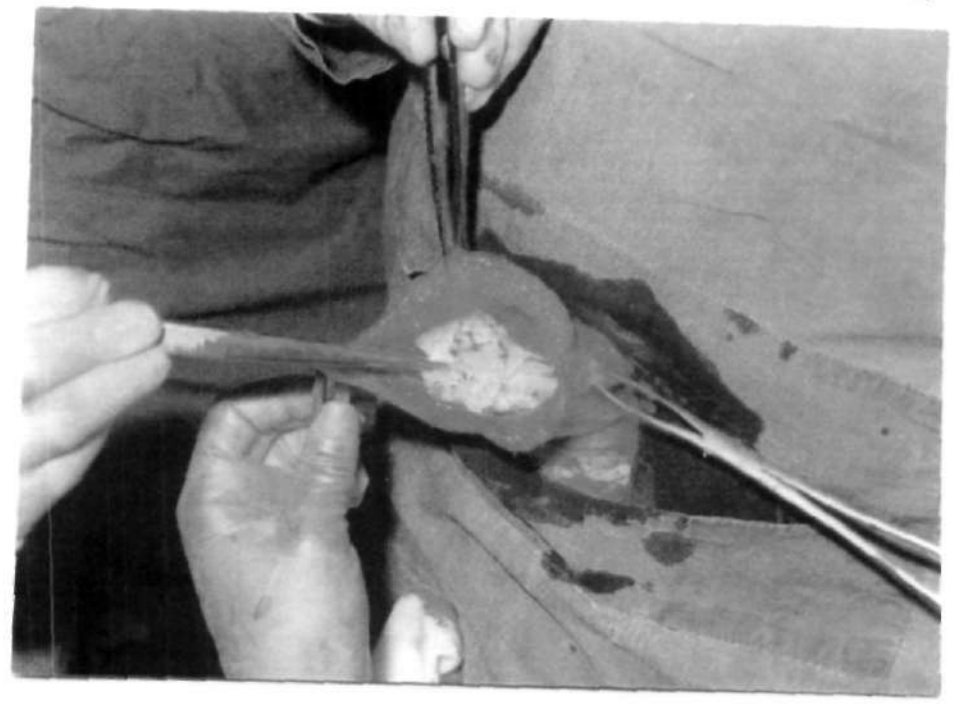


PLATE XV: *Polythene bags being placed into the rumen of experimental sheep.*

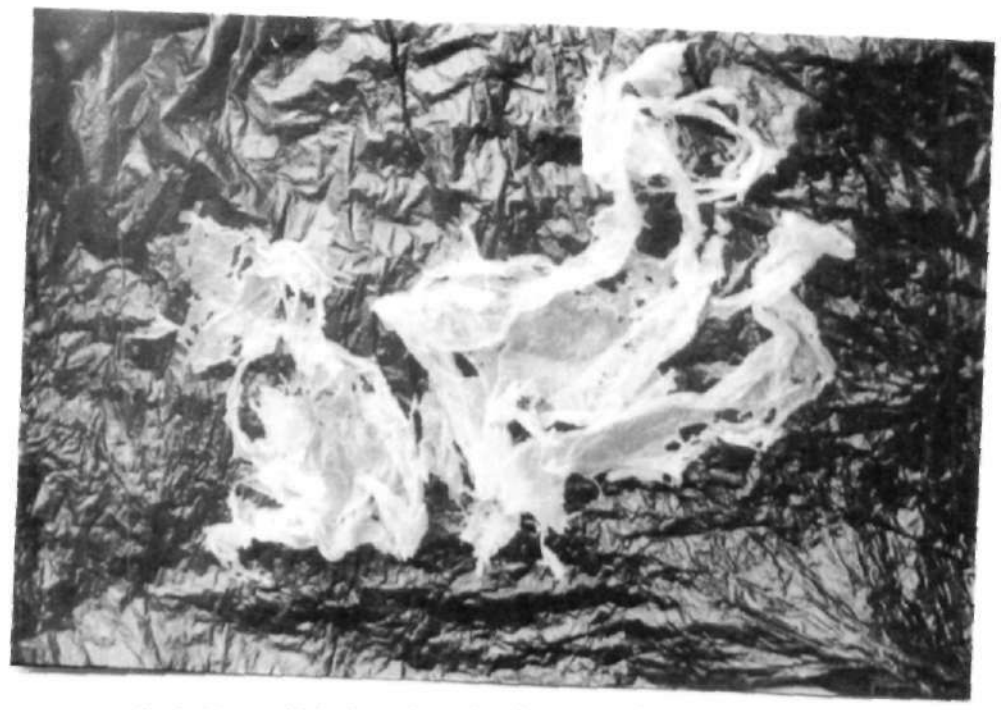


PLATE XIV: *Polythene bag shreds removed from rumen at second rumenotomy. 84 days post insertion.*

groups. Serum potassium value (mE/l) for T 1 was 4.86 while it was 4.67 and 4.44 in T 2 and T 3 groups. Alkaline phosphate value (u/l) was 67.2, 45.9 and 42.0 for T 1, T 2 and T 3 respectively. Magnesium value (mg / l) was 2.88 for T 1 while it was 2.09 and 2.81 for T 2 and T 3 groups. Chloride value (mEq/l) was 107.52, 104.74 and 106.52 for T 1 and T 3 respectively.

4.3.4 Rumen Fluid Analysis

(i) Rumen fluid colour, consistency and odour

Rumen fluid from animals in T 1 had normal colour of gray to brownish green while those of T 2 and T 3 were slightly abnormal tending towards milky-gray. Consistency of the rumen fluid in T 1 was normal which was slightly viscous while those of T 2 and T 3 were slightly watery. Odour in all the three groups was not repellant but slightly stale in the T 3 group.

(ii) Rumen fluid pH

Rumen fluid of T 1 animals was normal (6.7) while an acidic pH was recorded in T 2 (5.7) and T 3 (5.3) in phase I treatment. In phase II treatment the pH was also acidic in T 2 and T 3 (Table 4:5).

(iii.) Sedimentation Activity Time (SAT)

SAT was reduced in the treatment groups in both phase I and II, and it was lowest in the T3 group (1 minute) in both phases (Table 4:5)

(Iv.) Redox potential

Redox potential was found to decrease in T 2 and T 3 groups in both phase I and II (Table 4:5)

TABLE 4:5 RUMEN FLUID PARAMETERS OF SHEEP WITH EXPERIMENTAL POLYTHENE BAG RUMEN IMPACTION

	INITIAL VALUES			PHASE I			PHASE II		
TREATEMENT LEVEL	T1	T2	T3	T1	T2	T3	T1	T2	T3
MANAGEMENT	75:25[a]	75:25[a]	75:25[a]	75:25[a]	75:25[a]	75:25[a]	Grazing	Grazing	Grazing
RUMEN pH	6.7	6.8	6.6	6.7	5.7	5.3	6.6	5.8	5.0
REDOX POTENTIAL (mins)	4	3	6	4	3	4	4	3	3
SEDIMENT ACTIVITY TIME (mins)	4	5	5	5	3	1	4	2	1
TOTAL ACIDITY (units)	18.3	18.2	16.8	18.0	19.2	24.8	18.7	20.0	23.6
PROTOZOA COUNT (10^4/ml	28.7	30.2	27.9	28.2	33.4	40.6	30.0	35.10	42.5
BACTERIA COUNT (10^6/ml)	5.4	5.0	5.7	5.5	3.6	3.8	5.6	3.1	3.4

Key:
Phase I: Animals were intensively managed
Phase II: Animals were semi-intensively managed

[a] Digiteria smutsi : hay (75%) and grain diet (25%) composed of 100k cotton seed cake and 1kg mineral salt.
SE: Standard Error
T1: Control (No polythene bag in rumen)
T2: Low treatment (10 pieces - 0.9g of polythene bag in rumen)
T3: High treatment (20 pieces - 18.0g of polythene bag in rumen)

(v.) Total acidity

Total acidity of rumen fluid was higher in the T 3 group in both phase I (24.8 units) and phase II (23.6 units) (Table 4:5).

(vi.) Morphologic examination

Total bacterial count decreased with increase in the level of RI from 5.5 x 10^9 / ml in T 1 to 3.6 x 10^9 and 3.8 x 10^9 / ml in T 2 and T 3 respectively in phase I . This was further reduced in phase II in the T 2 (3.1 x 10^9 / ml)and T 3 (3.4 x 10^9 / ml) groups (Table 4:5).

At normal rumen pH of 6.7 , predominant bacteria type are Gram negative cocci and Gram positive cocci, rods and short chains as observed in T 1. In more acidic pH observed in T 2 and T3, Gram negative cocci, rods and chains and Gram positive cocci, rods predominates (Table 4:6).

Total protozoal count increased with RI from 28.2 x 10^4 / ml in T 1 to 33.4 x 10^4 / ml and 40.6 104 / ml in T 2 and T 3 respectively in phase I. This was further increased in phase II (Table 4:5).

The holotrichs decreased while entodiniomorphs increased from phase I to phase II (Table 4:7).

4.3.5 Radiographs

Plain radiographs did not show clear outline of abdominal organs. while contrast radiographs taken after a barium meal showed clear outline of the rumen and its content although the contents were not identifiable.

TABLE 4:6 MORPHOLOGIC EVALUATION OF RUMEN FLUID IN SHEEP WITH POLYTHENE BAG INDUCED IMPACTION

Sampling time (weeks)	Rumen pH	Rumen motility per 2 minutes	Bacteria type
0	6.7	4.0	-ve cocci
			+ve cocci
			+ve rods, short chains predominates
3	5.7	2.0	-ve cocci
			-ve rods
			+ve cocci
			predominates
6	5.8	3.5	-ve cocci
			-ve rods
			+ve cocci
			predominates
8	5.5	1.5	-ve cocci
			-ve rods
			+ve cocci, rods
			predominates
10	5.4	2.0	-ve cocci
			-ve rods, chains
			+ ve cocci
			predominates
12	5.4	1.5	-ve cocci
			-ve rods
			+ve cocci, rods
			predominates

Key:
+ve = Gram positive -ve = Gram negative.
Week 0 - 1: Animals were intensively managed (Acclimatization)
Week 1 - 6: Animals were intensively managed
Week 6- 12: Animals were semi-intensively managed

TABLE 4:7 EFFECT OF POLYTHENE BAG RUMEN IMPACTION ON SHEEP RUMEN pH AND PROTOZOAL NUMBERS

Sampling time (weeks)	Diet[a]	Rumen pH	Total Protozoal Count (x 10^4/ml)	Total Holotrichs (x 10^4/ml)	Total Entodiniomorphs (x 10^4/ml)
0	75:25	6.7[b]	32.7[b]	1.2[b]	31.5[bc]
3	75:25	6.3[b]	51.4[c]	1.1[b]	50.3[cd]
6	75:25	6.5[b]	45.9[c]	1.7[b]	44.2[dc]
8	Grazing	6.0[bc]	120.0[c]	1.1[bc]	118.9[d]
10	Grazing	5.7[b]	145.4[d]	0.2[c]	145.2[e]
12	Grazing	5.8[c]	155.1[d]	0.1[c]	155.0[e]
SE		1.30	11.20	0.40	11.20

Key:

[a] Digiteria smutsi: hay (75%) and grain diet (25%) composed of 100 kg maize, 100 kg cotton seed cake and 1kg mineral salt.

Week 0 - 1: Animals were intensively managed (Acclimatization)

Week 1 - 6: Animals were intensively managed

Week 6 - 12: Animals were semi-intensively managed

b, c, d, e means with the same column bearing different superscripts differ significantly ($P < 0.05$)

4.4 DISCUSSION

The rectal temperature, pulse and respiratory rates in this study did not increase as observed by Lal et al., (1989). This could be due to the different materials used for the rumen impaction (RI).The decrease in rumen motility was similarly observed by Abdullahi and Muhamm (1981). This seems that the factors causing rumen motility are the same regardless of the indigestible material causing the RI. The decrease in body condition score observed in this study is similar to the observations made by Abdullahi and Muhammed (1981) and Sanni et al., (1995; 1998). This means that body condition score could be used as one of the clinical indicators of RI in small ruminants.

The weekly mean weight loss observed in sheep with plastic bag RI, may be as a result of reduced production and absorption of volatile fatty acids (VFAs), across the rumen wall. The concentration of VFAs are dependent on rumen motility, microbial population and proportions among other factors (Russell and Hespell, 1981) which were observed to have reduced in this study. This observation could be responsible for reduced production and absorption of VFAs in the rumen. The phase II treatment experienced more of the weekly weight loss than the phase I treatment. This is probably due to additional stress of grazing in which more energy is expended. The non biodegradable nature of the polythene bags makes continuous contact with the rumen wall during rumen contraction leading to gradual damage to the epithelium which may result in ruminitis and possibly hyperkeratosis (Baldwin and Allison, 1983). This may also contribute to the reduced production and absorption of VFAs observed in this study.

The clinical signs observed in this study are similar to those earlier reported by

Abdullahi and Muhammad (1981). The distended abdomen, anorexia and poor body condition in RI may be attributed to the lodgement of indigestible materials in the rumen and the malabsorption of volatile fatty acids respectively. The presence of many polythene bags in the rumen allows for inter-weaving into a single entity due to ruminal contraction, the mass then settles on the ventrum of the rumen thereby compromising the space. Their movement at this stage is limited due to the weight of the material and it results in sustained abdominal distention. Among the factors that inhibit voluntary feed intake in ruminants such as fatigue, heat, high VFAs in the rumen and imbalance of microbial population is distention of the rumen with RI which reduces its activities (Dain et al.,1955). Polythene bags therefore, can serve as a constraint to animal production by interfering with the normal physiological processes of the rumen and consequently weight loss and even death due to starvation. During the course of rumen motility the non-biodegradable materials have a chance of getting lodged in the rumeno- reticular (R-R) groove causing an obstruction. This interferes with eructation and so accumulation of gases (secondary gas tympany)and the abdominal distention observed in cases of RI. However, depending on the amount of the material lodged up in the R-R groove, the continuous ruminal motility may cause the material to return into the rumen. This may accounts for the intermittent bloat observed in some cases of RI.

Bartley et al., (1975) reported a linear correlation between the molar proportions of propionate in the rumen VFAs and the efficiency with which metabolizable energy was used for fattening. The presence of polythene materials in the rumen will hamper the absorption of the VFAs because they occupy a large surface area in the rumen and trap the

VFAs between the mass.

Reports is the literature on haemogram values of ruminants with RI indicate non specific conclusions, because of other rumen disorders causing similar effects (Niederman et al., 1990). This study observed an increase in white blood cells, and decreases in red blood cells, haemoglobin concentration and total protein. This observation has no readily available explanation for now except for the observed reduced feed intake as indicated by the studies of Aganga et al., (1989).

The electrolyte values were observed to decrease in value. This observation may be due to decrease feed intake Aganga et al., (1989).

Rumen fluid colour, consistency and odour showed no remarkable differences indicating that RI due to indigestible material such as polythene bags can be distinguished from RI due to grain overload. The observed acidic rumen environment in this study may indicate that polythene bag RI can lead to accumulation of organic acid and ruminal stasis (Crichlow and Leeh, 1986).

The recorded increase in bacterial count is due to acidic rumen environment and decrease in holotrichs protozoa as observed by Aganga et al., (1989).

Contrast radiograph using barium meals may be a promising diagnostic tool for RI caused by indigestible materials. Further studies are needed in this area.

4.5 CONCLUSION

This study highlights the effect of polythene bags in sheep on various parameters. The decrease or increase of any of these parameters may be used to consider among many other causes of RI indigestible rumen materials. The study strongly suggests the diagnosis of RI using body weight losses of sheep raised especially on extensive management system.

CHAPTER FIVE

5.0 GENERAL DISCUSSION , CONCLUSION AND RECOMMENDATIONS.

Rumen impaction with indigestible or non-biodegradable material is fast becoming a major problem to sheep production. This is probably due to the advent of the petroleum boom in Nigeria and the subsequent establishment of several petroleum by-product industries such as the plastic industries. Although these set ups have made packaging cheaper and easier the fact that the materials are non biodegradable and inadequately disposed predisposes them to persist for a long period in the environment and ingestion by animals, especially during the dry season when pasture is scarce resulting in rumen impaction . The lodgement of these materials coupled with other garbage material in the sheep rumen result in weight loss, losses through death or slaughter of sick animals and high cost of surgical treatment of rumen impaction. All these may constitute a source of major economic loss to sheep production in Nigeria. The following recommendation are therefore drawn:

1. A national livestock survey should be conducted to determine the incidence and prevalence rate of rumen impaction with non-biodegradable and other garbage material. This will help to assess their importance to livestock since this condition has not been adequately documented in Nigeria. This will help to determine the economic implications of rumen impaction to livestock production in Nigeria.
2. The annual national economic loss resulting from the condition should be quantified. This would include losses incurred from weight loss resulting in poor prices of animals, losses

through high cost of surgical treatment, death and premature culling of sick animals.

3. Enforcement of strict legislation on waste disposal and environmental protection. The polythene material which constitute the most conspicuous refuse littering in most of our cities must be adequately disposed by incineration.
4. Enforcement of strict legislation on confinement of animals especially in our towns and cities. This will avert the exposure of animals to environmental hazards.
5. Government policy for plastic industries to produce biodegradable packaging materials which would not persist in the environment. Production of other packaging materials such as paper, cardboards, bottles, tins and heavier plastics which have an advantage of being recycled should be encouraged.
6. Public education on the hazards of careless waste disposal should be embarked upon. Health status of animals has a direct or indirect effect on man in terms of transmission of zoonotic diseases and / or reduction of sources of animal protein.

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APPENDIX 4:1 INTAKE OF SHEEP: HAY 3% CONCENTRATE 1% (75:25) BODY WEIGHT

Weighing Date	Animal Tag No.	1886		1574		1505		1810		1531		1648		1645		1620		1664	
15/7/94	Animal Weight (Kg)	21.0		32.0		27.1		26.0		30.5		24.0		30.0		34.0		35.0	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	630	210	960	320	813	271	780	260	915	305	720	240	900	300	1020	340	1050	350
22/7/94	Animal Weight (Kg)	21.0		32.5		27.5		24.7		30.5		23.5		30.5		33.0		35.5	
	Feed	Hay	Conc	Hay	Cone	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	630	210	975	325	825	275	741	247	915	305	705	235	915	305	990	300	1065	355
29/7/94	Animal Weight (Kg)	20.0		31.5		26.5		25.0		30.5		25.5		28.5		31.0		33.0	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	600	200	945	315	795	265	750	250	915	305	765	255	855	285	930	310	990	330
5/8/94	Animal Weight (Kg)	20.3		31.5		27.5		26.0		30.0		25.5		28.0		31.0		34.0	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	609	203	945	315	825	275	780	260	900	300	765	255	840	280	930	310	1020	340
12/8/94	Animal Weight (Kg)	20.1		31.0		27.0		26.7		30.5		26.0		28.0		31.0		34.0	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	603	201	930	310	810	270	801	267	915	305	780	260	840	280	930	310	1020	340
19/8/94	Animal Weight (Kg)	20.0		31.5		27.0		27.0		30.5		26.0		28.0		31.0		34.2	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	600	200	945	315	810	270	801	270	915	305	780	260	840	280	930	310	1026	342
26/8/94	Animal Weight (Kg)	20.0		30.0		26.0		27.8		31.6		26.5		27.9		30.5		33.9	
	Feed	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc	Hay	Conc
	Amt (gm)	600	200	900	300	780	260	834	278	948	316	795	265	837	279	915	305	1017	339

APPENDIX 4:2 CRITERIA FOR BODY CONDITION SCORING (Russel, 1978)

Score 0: extremely emaciated and on the point of death. No muscular or fatty tissue between the skin and bones.

Score 1: Spinous and transverse process are felt to be prominent and sharp. Fingers pass easily under the ends and between each process. Eye muscle area is shallow with no fat cover.

Score 2: Spinous processes are prominent but smooth and individual process felt only as fine corrugations. Transverse processes are smooth and rounded and it is possible to pass fingers under the ends with little pressure. Eye muscle area is of moderate dept but with little fat cover.

Score 3: Spinous processes are detected only as small elevations. They are smooth rounded and individual bones only felt with pressure. Transverse processes are smooth, well covered, and firm pressure is required to feel over the ends. Eye muscule area are full with moderate degree of fat over.

Score 4: Spinous processes are just detected with pressure as a hard line. Transverse processes cannot be felt. The eye muscle area are full and have covering of fat.

Score 5: The Spinous processes cannot be detected even with firm pressure and there is a depression beween the layers of fat in the position where the spinous processes would normally be felt. Transverse processes cannot be detected. Eye muscle areas are very full with very thick fat cover. There may be large deposits of fat over the rump and tail.

APPENDIX 4:3 MATERIALS AND METHODS FOR DETERMINATION OF HAEMOGRAM

White blood cell (WBC) concentration, haemoglobin concentration, red blood cell concentration, packed cell volume, mean corpuscular volume, total plasma protein and differential WBC count were determined by the methods described by Coles (1986).

White Blood Cell/Haemoglobin Concentration

The total white blood cell and Hb concentration were determined using the coulter counter. A 1:500 dilution of blood was made by adding 20 ml of coulter isotonic diluter to 20 ul of whole blood in a cuvet and the coulter counter reading was recorded.

Red Blood Cell/Packed Cell Volume/Mean Corpuscular Volume

The total RBC, PCV and MCV were determined using the coulter counter. A 1:50,000 dilution of the blood obtained was made by adding 20 ml of isotonmic diluter to 100 ul of WBC dilution in a cuvet and the coulter counter reading was recorded.

Total Plasma Protein

The total plasma protein (TP) was determined by the refractometric method. A capillary hematocrit tube approximately 7cm in length and having a bore of about 1mm was filled with blood by capillary action. The outside was carefully dried with a piece of guaze and the opposite end of the tube was sealed over a burner. The tube was then placed in a centrifuge. After centrifugation, the tube was placed on a special refractometer to determine the TP.

Differential WBC Count

A drop of the blood obtained was placed on a microscope glass slide and spread out to give
a thin film. This was dried, fixed in methanol for 10 minutes stained with 10% Giemsa stain
and the percentage differential cells counted under the X100 (oil immersion) objective of the microscope.

APPENDIX 4:4 MATERIALS AND METHODS FOR DETERMINATION OF BLOOD UREA CONCENTRATION

Blood urea concentration was determined using the method described by Archer and Robb (1925).

Reagents:

1. Ethanol, 30% (V/V): 30 mls of absolute ethanol diluted with 100 ml of water.
2. Urease suspension: 1 tablet of urease, in a glass stoppered test tube, 5 ml of reagent 1 added to it.
3. Sodium hydroxide, saturated solution of water: 240 g of NaOH pellets, A.R., added to 400 ml of water. Flask is stoppered and left for 2 days at room temperature, with occasional mixing. The clear supernatant liquid is decanted.
4. Sodium hydroxide, 10% (w/v) in water: 45 ml of water is added to every 10 ml of reagent 10 ml of this solution is diluted to about 25 ml with water and titrated with Ammomum Chloride. (Titrate is about 9.5-10.5 ml).
5. Nessler's double iodide solution: 15 g of potassium iodide, A.R., is dissolved in about 10 ml of water. 20 g of mercuric iodide is dissolved in it, and diluted to 100 ml with water. Solution is filtered and filtrate diluted to 200 ml.
6. Nessler's reagent: 350 ml of reagent 4 is mixed with 75 ml of reagent 5 and 75 ml of water. The solid is allowed to settle and the clear supernatant

liquid used.

7. Sulphuric acid, 0.67 N: 19 ml of concentrated H_2SO_4, A.R, s.g 1.840 is diluted to one litre with water.

8. Sodium tungstate solution. 100 g of $Na_2WO_4.2H_2O$ A.R., is dissolved in one litre of water, to give a solution alkaline to phenophthalein.

Standards:

1. Stock standard solution: 1.4985 g of ammonium chloride, A.R. (dried in Vacuo over H_2SO_4) is dissolved in 500 ml of water and kept at 4°c.
2. Dilute standard solution. 4.70 ml of standard 1 is diluted to one litre with water and kept at 4°c. 9.0 ml of this standard represent a blood urea concentration of 50 mg/100 ml when treated with 2.0 ml of Nessler's reagent

0.20 ml of blood was taken into a centrifuge tube containing 2.0 ml of water. 0.20 ml of freshly prepared urease suspension, mixed, stoppered and incubated at 50°c for 30 minutes. 0.30 ml of H_2SO4 was added and mixed. 0.30 ml of Na_2WO_4 solution was added and mixed. 4.0 ml of water was also added and then centriguged at 2,200 r.p.m for 5 minutes. 4.0 ml of water was measured into a test tube and 5.0 ml of supernatant liquid was added. In another test tube 9.0 .ml of standard solution 2 was measured. 2.0 ml of Nessler's reagent added to each test tube and mixed. The solutions were compared immediately in Hilger Biochem absorptiometer, with filter No. 52, 2 cm cells, and setting the optical density scale to zero against water.

Blood urea concentration is given by the formula . $50 \times \frac{T}{S}$

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Where T and s are galvanometer readings of the test and standard solutions. Result is then expressed as Blood urea: mg/100 ml or mg/dl.

APPENDIX 4:5 EQUIPMENT, REAGENTS AND METHODS FOR DETERMINATION OF SERUM SODIUM AND POTASSSIUM VALUES

Sodium and Potassium valves were determined using the flame photometry described by Wolf et al., (1972).

Equipment and Reagents:

1. IL flame photometer: model 143. Aspiration rate set at 1.3 ml/minute.
2. Ultramicrodilator: Sample syringe set to take up to microliters and flush syringe set to deliver 2.0 ml of working lithium diluent (1:200). The dilutor is flushed and cleaned periodically.
3. Standards for serum
   a) 120/2 mEq./litre of Na/K
   b) 140/5 mEq./litre of Na/K
   c) 160/8 mEq./litre of Na/K
4. Stock Lithium diluent, 1500 mEq./litre
5. Working Lithium diluent, 150 mcq./litre: 100 ml of the stock lithium diluent is diluted to one litre with deionized water.

10 microliters of standard or sample was taken up and flushed with 2.0 ml of lithium diluent into the large Auto Analyser cups, capped and mixed. Duplicate dilution were prepared for each standard and sample. Using the appropriate standards the digital read out for sodium and potassium was set with the respective balance knobs "B" and "D" to the known values for the standard.

APPENDIX 4:6 EQUIPMENT, REAGENTS AND METHOD FOR DETERMINATION OF SERUM CHLORIDE VALUE.

Chloride value was determined by the method described by Schales and Schales (1941).

Reagents

1. Mercuric intrate solution: 2.9 to 3.0 gm of mercuric nitrate Hg $(No_3)_2$ dissolved in a few hundred ml of water with the addition of 20 ml of 2N HNO_3 and solution made up with water to 1000 ml.
2. Indicator: 100 mg of diphenylcarbazone dissolved in 100 ml of 95% alcohol and stored in the dark in a refrigerator.
3. Chloride standard: Nacl dried at 120° and 584.5 gm dissolved in water and made up to 1000 ml. The solution contains 10 milliequivalents of chloride per litre. It is used for the standardization of each batch of Hg $(NO_3)_2$ solution. 2 ml of 0.01N Nacl standard solution are titrated against N/60 Hg $(NO_3)_2$.

To 1.8 ml of water in a 25 ml Erlenmeyer flask was added 0.2 ml of serum and 0.06 ml (= 4 drops) of indicator solution. $Hg(NO_3)_2$ was then added from a microburette calibrated at 0.01ml intervals. The size of the drops was such that 1 ml equals about 100 drops. The slightly turbid mixture was first salmon red and changed after titration had started, to deep violet. As more $Hg(NO_3)_2$ was added, the solution becomes clear and pale yellow to colourless. At the end point there was a sharp change to pale violet which was observed without difficulty.

A factor F which is calculated from the result of this titration,and the amount of $Hg(NO_3)_2$ solution (in ml.) used for the titration of 2 ml of serum + water is multiplied to give directly the amount of mEq of chloride per litre of serum.

F = 100/Z, where Z is the amount of $Hg(NO_3)_2$ solution used for the titration of 2 ml Nacl standard.

Serum chloride mEq/L = F x S where S is the amount of solution used for the titration of 2 ml of serum + water.

APPENDIX 4:7 EQUIPMENT, REAGENTS AND METHOD FOR DETERMINATON OF SERUM ALKALINE PHOSPHATE VALUE.

Alkaline phosphate values were determined using the photoelectric colorimeter described by Bessey et al., (1946).

Equipment and Reagents:

1. Photoelectric colorimeter adapted to 0.5 ml volume measurements.
2. Wire rack to hold 100 tubes.
3. Reagent A: 7.50 gm (0.1 mole) of glycine and 9.5 mg (o.001 mole) of $Mgcl_2$ dissolved in 700 - 800 ml of water and 0.085 mole (e.g. 85 ml, 1N) NaOH was added and diluted to 1 litre.
4. Reagent B: 0.4% disodium p-nitrophenyl phosphate in 0.001N Hcl. The pH was adjusted to 6.5 - 8.0 with addition of acid or base. Reagent was stored frozen.
5. Reagent C: Mixture of equal part of Reagents A and B with pH adjusted to 10.3 - 10.4 with the addition of a little strong NaOH or Hcl. Reagent was stored frozen.
6. Standards: Solutions containing 1, 2, 4 and 6mm per litre of P-nitrophenol.

1 ml of reagent C was measured into six test tubes placed on a rack placed in a water bath before the addition of serum. 0.1ml of serum was then added and time noted. Exactly 30 minutes later 20 ml of NaOH was added. This addition stopped the reaction and diluted the samples which were then transferred to colorimeter tubes and read at 400 to 420 mu = R_1 and a second reading R_2. R_1 and R_2 are converted into optical densities (-10g transmission or 2 - 10 g per cent transmission) = D_1 and D_2. Then $D_1 - D_2 = Dc$, the corrected density. Dc was used to construct a standard curve from which the serum values were calculated. A "millimole unit" is defined as the phosphatase activity which will liberate 1mm of nitrophenol per litre of serum per hour; that is, it is expressed as u/L.

APPENDIX 4:8 EQUIPMENT, REAGENTS AND METHOD FOR DETERMINATION OF SERUM MAGNESIUM VALUE

Magnesium values were determined by the method of atomic absorption spectrometer at absorption wave length of 2852 Amstroms. (Wolf et al., 1972).

Equipment and Reagents:

1. Microdilutor: equipped with sample syringe set to pick up 40 ul of specimen and flush syringe set to dispense 2.0 ml of deionized water.
2. Perkin-Elmer Atomic Spectrophotometer model 403: equipped with 3-slot burner head and magnesium cathode lamp (15 min. warm up time). Acetylene-air fuel mixture
   a. Range: uv
   b. Wave length: 285
   c. Silt: 5 (3.0mm; 20 A)
   d. Flame: Reducing (yellow traces)
3. Stock Magnesium Standard: 100 mEq/L. 1.216gm of magnesium metal dissolved in 10ml of concentrated HC1, and diluted to 1.0 litre with deionized water.
4. Intermediate Magnesium Standard: 1:100, 1:50 and 1:25 dilutions of the stock standard was made with deionized water. This corresponds to concentrations of 1.0 mEq/L, 2.0 mEq/L and 4.0 mEq/L.
5. Working Magnesium Standards: each intermediate standard was diluted with deionized water.

40ul of non-hemolysed serum and controls in duplicates were diluted using auto-Analyser cups and absorbance read. Magnesium values are calculated from the formula:

$$\text{mEq//L of mg} = \frac{\text{A unk .X C std. (mEq./L)}}{\text{A std.}}$$

Where A unk = absorbance of unknown

A std = absorbance of standard

C std = concentration of standard magnesium solution to most nearly corresponding to the value of the unknown.

APPENDIX 4:9 EQUIPMENT, REAGENTS AND METHOD FOR DETERMINATION OF SERUM ALBUMIN VALUE.

Albumin values were determined by the method outlined by Wolf et al., (1972). Using a spectrometer.

Equipment and Reagents:

1. Gilford 300N spectrometer set at 615 nm. and fitted with standard evacuation cuvette.
2. Bromocresol green indicator: available in set of 50 tubes of lyophilized dye by American monitor Albumin kit #1006. Stored under refrigeration.
3. Buffered detergent diluent: American monitor Albumin kit #1006 stored under refrigeration.
4. Standard Albumin solution: Human Albumin (Fraction V or Mercaptalbumin) approximately 10 - 11gm % converted nitrogen assay to Gm %, protein by: 1.0 mg of protein nitrogen/ml = 6.25 mg protein/ml.
5. Ultramicro dilutor: Sample syringe set to take up 20 ul of sample and dispensing syringe set to deliver 5.0 ml of buffered detergent diluent.

A blank reagent was prepared by dispensing 5.0 ml of buffered detergent from the dilutor into a tube of lyophilized dye and mixed by inversion. Then using the microdilutor, 20ul of standard, control or serum specimen was taken up and 5.0 ml buffered detergent was dispensed into a series of lyophilized dye tubes and mixed by inversion. The absorbance of all samples was determined at 615 nm against the reagent blank using the spectrometer. Standards were plotted on linear graph paper and controls and tests were determined using the calibration graph. If standards have proven to be linear, the concentration of controls and specimens was calculated by the formula:

$$\text{Gm \% of specimen} = \frac{\text{Conc. of std}}{\text{A of std}} \times \text{A of specimen}$$

APPENDIX 4:10 RUMEN FLUID ANALYSIS

Rumen fluid colour consistency and odour (Dirksen, 1979)

Rumen fluid in a test tube were observed for abnormal colours, consistency and odour. Normal colours varies from olive to brownish green to ygellowish-brown. Abnormal colours are milky-grey and greenish-black.

The consistency of rumen fluid is normally slightly viscous, while a watery rumen fluid signifies inactivity and may contain bubbles.

The odour is normally aromatic and not repellant. Abnormal odor include: repulsive musty, foul odour, penetrating acid and stale, indifferent odour.

Rumen fluid pH (Dirksen, 1979)

Rumen fluid pH was determined immediately after collection, by an electrical pH meter.

Sedimentation Activity Time (SAT) (Dirksen, 1979)

SAT was assessed by placing a sample of the rumen fluid in a glass test tube and recording the time in minutes, it takes for the fine particles to settle out and the large particles to float to the surface.

Redox Potential (Broberg, 1957 / 58)

20 ml of freshly collected rumen fluid was placed in a test tube. 1 ml of 0.03% methylene blue solution was added and mixed with a glass stirrer. The time required for decoloration of the sample is measured in minutes, using a plain rumen fluid in another test tube as a basis for comparison.

Total Acidity (Salnina and Rossow, 1964)

10 ml of freshly collected rumen fluid was placed in a test tube. 1-2 drops of phenolpthalein was added and mixed with a glass stirrer. The mixture was then titrated with N/10 NaOH until it became flesh-colored. The total acidity (in units) in the rumen fluid is obtained from the volume of NaOH required (in ml) multiplied by 10.

Morphologic Examination (Moir and Masson, 1952; Dirksen, 1979)

A wet mount was made by placing one drop of rumen fluid on a slide and covered with a slip. The slide was briefly warmed by holding over a lighted match. It was then examined at a magnification of 100. The density of the protozoa was estimated as abundant = +++ (20 protozoa per field), moderate = ++ (10 protozoa per field), few = + (less than 10 protozoa per field), and none = --

Counting of protozoa was done by using a modified Mc Master Chamber (chamber depth 230 mm). Freshy collected and well mixed rumen fluid was filtered through gauze. A 1:10 dilution of the rumen fluid was made with normal saline in a leukocyte counting pipette together with a few drops of methylene blue solution. This was used to charge the McMaster counting chambers and the total protozoa was counted in the WBC area under the microscope. The protozoa was expressed as count per litre.

Bacterial Evaluation (Moir and Masson, 1952; Dirksen, 1979)

A drop of the rumen fluid was placed and smeared on a slide and air-dried. The slide was then fixed by gently heating the slide over a low flame of a Bunsen burner. The slide was cooled and stained for 2 minutes with gentian violet and washed with water. The slide was then treated with Gram's iodine for one minute, washed with water and decolorized for a few seconds with 95% alcohol. The slide was washed with water and counterstained with safranin solution for 1 minute, washed blot dried, and examined under the oil immersion lens.

The criteria for interpretation of the smear the presence or absence of morphologically distinguishable bacterial species characteristic of a normal rumen flora; the multiplicity or uniformity of forms; and the ratio of Gram +ve to Gram -ve bacteria..

Rumen Ammonia Nitrogen (Markham,1942)

Rumen Ammonia nitrogen was determined by a steam distillation unit as described by Markham (1942). Rumen fluid was collected in plastic bottles containing equal volume of 1% H_2SO_4 and strained through 2 layers of muslin cloth. 10 mls of the filtrate was placed in a test tube and a few drops of concentrated sulfuric acid was added and the sample was allowed to stand for 2 hours. This was then centrifuged at 3,000 rpm for 10 minutes. A 5 ml aliquot was distilled for 5 minutes using steam distillation with 2 ml of 40% NaOH. The distillate was collected in 5 ml of 2% boric acid solution and titrated against N/70 H_2SO_4.

The amount of ammonia nitrogen in the rumen fluid was obtained from the calculation below:

100 ml of 1 N H_2SO_4 = 14_g N

1 ml of 1 N H_2SO_4 = 0.014_g N

1 ml of N/70 H_2SO_4 = $\frac{0.014}{70} \times 1$

$= \frac{14}{70} = 0.2$ mg N

5 ml aliquot = x ml of N/70 H_2SO4

5 ml rumen fluid = xml x 0.2 mg N

100 ml rumen fluid = $\frac{x \times 0.2}{5} \times 100$

= x x4 mgN/100 ml rumen fluid.