



ISSN Print: 2664-9926
 ISSN Online: 2664-9934
 IJBS 2023; 5(1): 215-221
www.biologyjournal.net
 Received: 15-04-2023
 Accepted: 17-05-2023

Hassan Abdi Farah
 Department of Animal Science,
 Hargeisa Metropolitan
 University, Hargeisa, Somalia

Amina Osman Elmi
 Department of Animal Science,
 Hargeisa Metropolitan
 University, Hargeisa, Somalia

Yusuf Mohamed Adan
 Department of Animal Science,
 Hargeisa Metropolitan
 University, Hargeisa, Somalia

Sahra Ibrahim Jama
 Department of Animal Science,
 Hargeisa Metropolitan
 University, Hargeisa, Somalia

Corresponding Author:
Hassan Abdi Farah
 Department of Animal Science,
 Hargeisa Metropolitan
 University, Hargeisa, Somalia

Etiology and pathological consequences of indigestible foreign bodies in cattle rumen and reticulum at Bedeno Woreda Abattoir

Hassan Abdi Farah, Amina Osman Elmi, Yusuf Mohamed Adan and Sahra Ibrahim Jama

DOI: <https://www.doi.org/10.33545/26649926.2023.v5.i1c.563>

Abstract

Nearly four out of every ten cattle slaughtered at municipal abattoirs in the Horn of Africa region harbor indigestible foreign materials in their forestomach compartments. This research investigated the etiological factors and pathological consequences associated with the presence of foreign bodies in the rumen and reticulum of cattle slaughtered at Bedeno Woreda Municipal Abattoir, located in the West Hararghe Zone of eastern Ethiopia. A cross-sectional research was conducted from November 2021 to April 2022, incorporating both ante-mortem assessment and post-mortem inspection of 420 cattle selected through systematic random sampling. Each animal was evaluated for age, sex, body condition, breed type, and geographic origin prior to slaughter. Following evisceration, the rumen and reticulum were carefully opened, and all foreign materials were collected, classified, photographed, and weighed. Gross pathological changes in the forestomach wall were recorded for every positive case. The overall prevalence of foreign bodies was 41.2% (173 of 420 cattle). Plastic materials constituted the dominant foreign body type at 28.9%, followed by cloth and textile fragments (21.6%), metallic objects (18.3%), leather fragments (11.7%), rope and twine (8.4%), stones and gravel (6.2%), and mixed items (4.9%). The rumen alone accounted for 58.7% of all positive cases, the reticulum alone for 19.4%, and both compartments simultaneously for 21.9%. Age, body condition, and sex were all significantly associated with foreign body occurrence ($p < 0.05$). Cattle older than seven years showed the highest prevalence at 63.1%, while animals in poor body condition reached 57.3% in the oldest age category. Pathological examination revealed that 67.6% of positive cattle exhibited some degree of mucosal damage, ranging from mild hyperemia and edema (34.1%) to moderate erosion and ulceration (22.5%) and severe transmural inflammation with adhesion formation (11.0%). Among cattle harboring metallic foreign bodies, 42.3% showed evidence of reticular wall penetration, and three cases (1.7%) presented with findings consistent with traumatic reticulopericarditis. The research also documented that the mean total weight of foreign material per positive animal was 387.4 grams, with individual loads ranging from 12.8 grams to 2,163.5 grams. Heavier foreign body loads correlated with more severe pathological changes and poorer body condition scores. These findings demonstrate that foreign body ingestion in cattle at Bedeno Woreda is not merely a matter of prevalence but carries tangible pathological consequences that compromise animal welfare and reduce the economic value of affected carcasses. Targeted interventions addressing environmental contamination, grazing management, and early veterinary detection are needed to mitigate the burden of this condition in eastern Ethiopian cattle populations.

Keywords: Etiology, pathological consequences, foreign bodies, rumen, reticulum, cattle, Bedeno Woreda, Abattoir, mucosal damage, traumatic reticulopericarditis

Introduction

An estimated 30% to 60% of cattle slaughtered at abattoirs across sub-Saharan Africa carry foreign bodies in their rumen, reticulum, or both compartments, according to data compiled from post-mortem examinations conducted over the past two decades ^[1, 2]. This range, while broad, consistently points to a problem of considerable magnitude that extends beyond simple curiosity and into the domain of animal welfare, food production economics, and public health policy. In the Horn of Africa, where livestock represents the backbone of rural

livelihoods, the ingestion of non-food materials by cattle carries consequences that ripple outward from the individual animal to entire pastoral communities [3].

The etiology of foreign body ingestion in cattle rests on an intersection of animal behavior, environmental conditions, and human activity. Cattle are obligate herbivores that rely on a prehensile tongue to gather forage, and they lack the dental and oral mechanisms that would allow them to reject small inedible items mixed in with their feed [4]. When natural forage becomes scarce, as routinely occurs during dry seasons in semi-arid zones, cattle expand their foraging range and become less selective about what they consume. This behavioral shift brings them into closer contact with anthropogenic waste deposited around settlements, markets, and roadways [5]. Plastic bags, cloth fragments, nails, wire segments, and leather scraps all enter the ruminant forestomach through this pathway, often without producing immediate clinical signs [6].

But the consequences of foreign body accumulation are far from benign. Non-metallic materials such as plastics and textiles can form large, compacted masses within the rumen that physically obstruct normal ruminal contractions and interfere with the passage of digesta through the reticulo-omasal orifice [7]. Over time, this leads to a cascade of digestive impairment: reduced voluntary feed intake, decreased rumination efficiency, altered volatile fatty acid profiles, and progressive weight loss [8]. Metallic foreign bodies pose an even more immediate threat. Sharp objects that settle in the reticulum can penetrate the reticular wall during forceful contractions, advancing through the diaphragm and occasionally reaching the pericardial sac. The resulting condition, traumatic reticulopericarditis, often progresses to heart failure and death if not diagnosed and treated promptly [9, 10].

Pathological changes associated with foreign body presence range from mild mucosal irritation to severe transmural inflammation, abscess formation, and peritoneal adhesions. The severity of tissue damage tends to correlate with both the type and the total mass of ingested material, as well as the duration of exposure [7, 11]. Few investigations, however, have systematically documented the spectrum of gross pathological findings alongside prevalence data in Ethiopian abattoir settings. Most existing reports have focused primarily on prevalence and risk factor analysis without detailed characterization of the tissue-level consequences [12, 13].

Bedeno Woreda, positioned in the West Hararghe Zone of the Oromia Region in eastern Ethiopia, represents a locality where the conditions favoring foreign body ingestion converge. The area supports a large cattle population managed under extensive and semi-intensive systems, and its proximity to growing market towns exposes grazing cattle to substantial volumes of discarded waste [14]. Previous investigations at the Bedeno Woreda Municipal Abattoir have confirmed foreign body prevalence rates above 30%, yet the pathological dimension of the problem has not been adequately addressed [11].

This research was therefore designed to fill that gap by combining prevalence estimation with a systematic assessment of the etiological factors and gross pathological consequences of foreign body ingestion in cattle slaughtered at the Bedeno Woreda Municipal Abattoir. Understanding the relationship between foreign body type, load, and tissue damage is necessary for developing effective prevention

strategies and for informing meat inspection protocols that protect both animal welfare and consumer safety.

Research Area Description

The research was centered on the Bedeno Woreda Municipal Abattoir, which operates within Bedeno town in the West Hararghe Zone of the Oromia Regional State, eastern Ethiopia. Bedeno Woreda lies at coordinates ranging from approximately 8°50'N to 9°05'N latitude and 41°25'E to 41°45'E longitude, with elevations spanning 1,400 to 2,200 meters above sea level. The woreda encompasses a land area of around 780 square kilometers and had an estimated cattle population of 94,300 head at the time of data collection, based on district livestock office records. Mixed crop-livestock farming dominates the agricultural landscape, with sorghum, maize, and groundnut serving as the principal crops alongside the rearing of cattle, goats, and camels. The municipal abattoir functions as the sole licensed slaughter facility within the woreda, handling an average throughput of 18 to 22 cattle daily. Bedeno town has experienced rapid population growth over the past decade, which has intensified waste generation and reduced the availability of uncontaminated grazing land around the urban fringe. Open waste disposal along access roads and market peripheries has been identified as a persistent issue by local environmental authorities.

Climatic and Environmental Conditions

Bedeno Woreda falls within the semi-arid to sub-humid agro-ecological zone, characterized by a bimodal rainfall regime. The short rains (belg) typically occur between March and May, and the long rains (meher) extend from June through September. Total annual precipitation ranges from 600 to 850 millimeters, with marked inter-annual variability that periodically triggers localized drought conditions. Mean daily temperatures fluctuate between 16°C and 28°C across the elevational gradient. The dry season, stretching from October through February, is the period of greatest forage deficit, during which cattle are forced to range more widely and forage more indiscriminately. Soil degradation resulting from overgrazing and deforestation has reduced the carrying capacity of communal grazing reserves. Surface water availability contracts sharply during dry months, concentrating livestock around shared watering points that are often located near settlement edges where waste accumulates. The convergence of feed scarcity and environmental pollution during these months creates the conditions most conducive to foreign body ingestion.

Material and Methods

Material

This cross-sectional research was conducted at the Bedeno Woreda Municipal Abattoir from November 2021 to April 2022, a period covering both the dry season and the onset of the short rains. Ethical clearance was obtained from the Institutional Animal Ethics Committee of Hargeisa Metropolitan University (Protocol No. HMU-IAEC-2021-031, dated October 3, 2021). A total of 420 cattle were enrolled in the research through systematic random sampling, selecting every third animal on the daily slaughter line until the target was met. The sample size was calculated using the formula for prevalence estimation with an expected prevalence of 40%, 95% confidence, and 5% precision, yielding a minimum requirement of 369 animals,

which was rounded up to 420 for added statistical power. Equipment and consumables included disposable gloves, stainless steel trays, graduated plastic containers, an electronic precision balance (0.1 g accuracy), a digital camera, sample storage bags, and pre-printed data recording forms. All recovered foreign materials were washed, air-dried, weighed individually and collectively, and classified into seven categories: plastic materials, cloth and textile fragments, metallic objects, leather fragments, rope and twine, stones and gravel, and mixed items.

Methods

Ante-mortem examination preceded slaughter for each enrolled animal. Data collected included estimated age (categorized as less than 3 years, 3 to 5 years, 5 to 7 years, or greater than 7 years based on dental examination), sex, body condition score (poor, medium, or good per established guidelines [15]), breed type (local zebu or cross-bred), and origin (peri-urban or rural). Following slaughter and evisceration, the rumen and reticulum were separated from the remaining gastrointestinal tract, opened along the greater curvature using a scalpel, and their contents emptied onto clean trays. Visual inspection was complemented by systematic manual palpation to identify embedded or

concealed items. Each foreign body was photographed in situ before removal. The mucosal surface of both compartments was then examined for gross pathological changes, which were graded as: no visible change, mild (hyperemia and superficial edema), moderate (erosion and focal ulceration), or severe (transmural inflammation, abscess, or adhesion formation). All data were entered into Microsoft Excel and analyzed using STATA version 17.0. Prevalence was expressed as a percentage with 95% confidence intervals. Associations between foreign body occurrence and categorical risk factors were tested with the Pearson chi-square statistic. Odds ratios and their 95% confidence intervals were computed. A p-value below 0.05 was considered significant.

Results

A total of 173 out of 420 cattle (41.2%) examined during the research period were positive for at least one type of indigestible foreign body in the rumen, reticulum, or both. The following tables and figures present the detailed findings regarding foreign body prevalence, type distribution, anatomical location, risk factor associations, and pathological consequences.

Table 1: Prevalence of foreign bodies in relation to host-associated risk factors (n = 420)

Variable	Category	Examined	Positive (%)	OR (95% CI)	p-value
Sex	Male	208	72 (34.6)	1.00 (Ref)	-
	Female	212	101 (47.6)	1.72 (1.16-2.54)	0.006
Age	< 3 years	78	21 (26.9)	1.00 (Ref)	-
	3-5 years	128	47 (36.7)	1.57 (0.85-2.92)	0.148
	5-7 years	112	52 (46.4)	2.35 (1.25-4.41)	0.007
	> 7 years	102	53 (52.0)	2.93 (1.54-5.57)	0.001
Body condition	Good	134	39 (29.1)	1.00 (Ref)	-
	Medium	162	63 (38.9)	1.55 (0.96-2.51)	0.073
	Poor	124	71 (57.3)	3.26 (1.96-5.43)	<0.001
Origin	Rural	236	84 (35.6)	1.00 (Ref)	-
	Peri-urban	184	89 (48.4)	1.69 (1.15-2.49)	0.008
Breed	Local zebu	356	152 (42.7)	1.48 (0.82-2.67)	0.189

Table 1 presents the prevalence of foreign bodies across key host-associated variables. Female cattle had a significantly higher prevalence (47.6%) than males (34.6%), with an odds ratio of 1.72 (95% CI: 1.16-2.54; $p = 0.006$). Age showed a clear gradient, with prevalence increasing from 26.9% in animals younger than three years to 52.0% in those older

than seven years. Body condition was the strongest predictor, as cattle in poor condition were 3.26 times more likely to harbor foreign bodies compared to those in good condition ($p < 0.001$). Peri-urban origin was also a significant factor, with a prevalence of 48.4% compared to 35.6% in cattle from rural areas.

Table 2: Gross pathological findings in the forestomach of foreign body-positive cattle (n = 173)

Pathological Grade	Description	Frequency	Proportion (%)
No visible change	Normal mucosa	56	32.4
Mild	Hyperemia, superficial edema	59	34.1
Moderate	Erosion, focal ulceration	39	22.5
Severe	Transmural inflammation, adhesions	19	11.0
Total	-	173	100.0

Table 2 summarizes the gross pathological changes observed in the forestomach wall of foreign body-positive cattle. While 32.4% of positive animals showed no macroscopically visible mucosal damage, the remaining 67.6% exhibited changes ranging from mild hyperemia and edema (34.1%) through moderate erosion and focal

ulceration (22.5%) to severe transmural inflammation with adhesion formation (11.0%). The severe category included three cattle (1.7% of all positive cases) with gross findings suggestive of traumatic reticulopericarditis, characterized by fibrinous pericardial adhesions visible upon thoracic inspection.

Table 3: Mean total weight of foreign bodies in relation to pathological grade

Pathological Grade	n	Mean Weight (g)	Range (g)
No visible change	56	148.6±87.3	12.8-412.0
Mild	59	326.1±164.8	34.5-789.2
Moderate	39	541.7±228.4	118.3-1,247.6
Severe	19	891.3±412.7	287.4-2,163.5

Table 3 reveals a clear dose-response relationship between the total weight of foreign material and the severity of pathological change. Animals with no visible mucosal damage carried an average foreign body load of 148.6 grams, whereas those with severe transmural changes had a

mean load of 891.3 grams, roughly six times higher. The widest range was observed in the severe category, extending from 287.4 grams to 2,163.5 grams, indicating substantial individual variation.

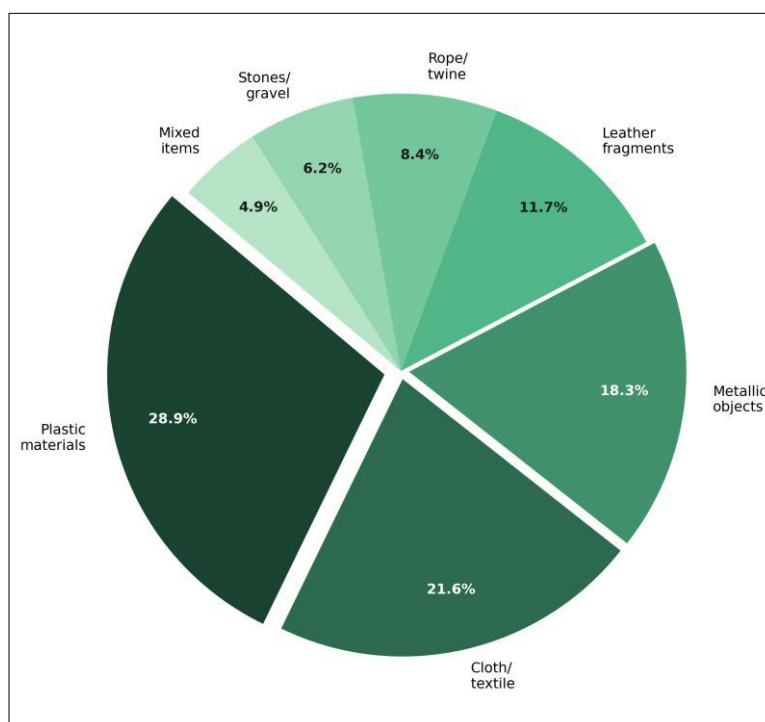
**Fig 1:** Proportional distribution of foreign body types recovered from positive cattle at Bedeno Woreda Municipal Abattoir (n = 173)

Figure 1 depicts the relative contribution of each foreign body category to the total. Plastic materials dominated at 28.9%, closely followed by cloth and textile fragments at 21.6%. Metallic objects accounted for 18.3%, making them the third most common type but by far the most

pathologically significant due to their capacity for reticular wall penetration. The remaining categories, including leather (11.7%), rope (8.4%), stones (6.2%), and mixed items (4.9%), collectively formed 31.2% of the total.

**Fig 2:** Heatmap showing the interaction between age group and body condition score in determining foreign body prevalence

Figure 2 presents a two-dimensional view of how age and body condition interact to influence foreign body prevalence. The darkest cells, representing the highest prevalence values, cluster in the upper right corner of the matrix: cattle older than seven years in poor body condition

reached 63.1%, the highest cell value. Conversely, young cattle in good condition showed only 14.3%, the lowest. This pattern confirms that the risk factors operate synergistically, and animals that are both old and nutritionally deprived face an especially elevated risk.

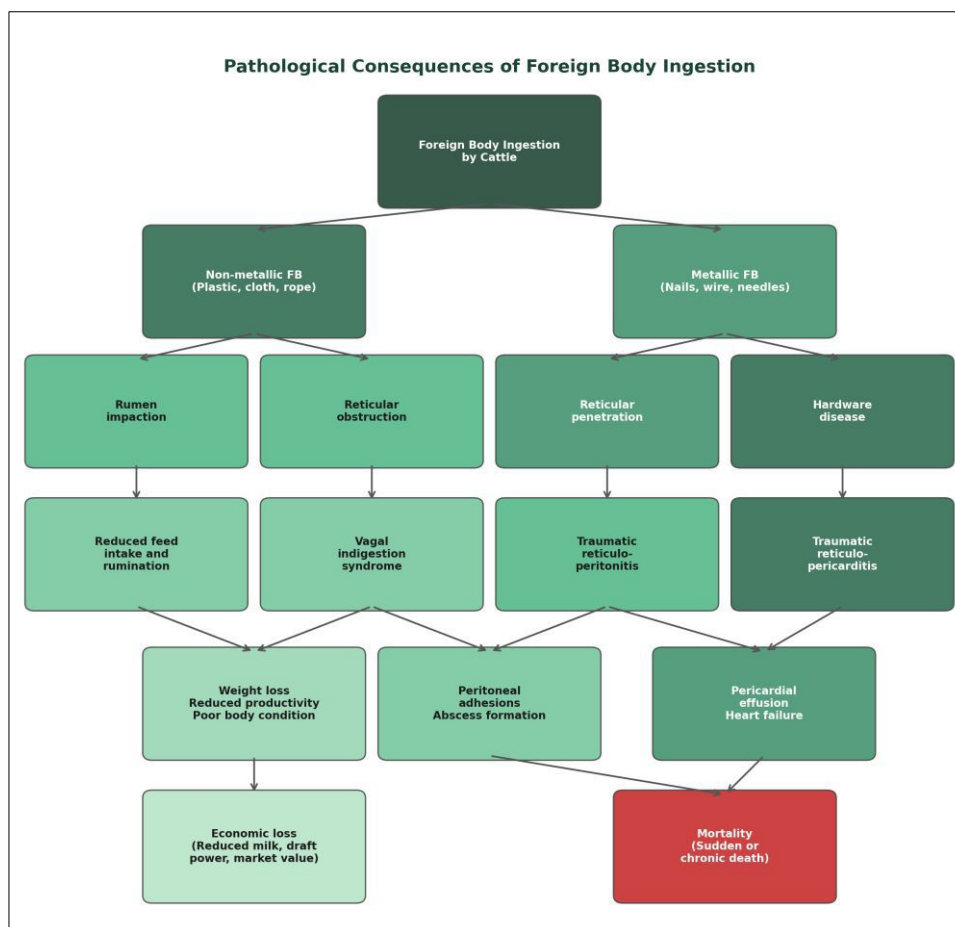


Fig 3: Pathological consequence pathway from foreign body ingestion to clinical outcomes in cattle

Figure 3 maps the pathological pathways that follow foreign body ingestion. Non-metallic materials primarily cause rumen impaction and reticular obstruction, leading to reduced feed intake, vagal indigestion syndrome, and progressive weight loss. Metallic foreign bodies follow a

more dangerous trajectory through reticular penetration, potentially resulting in traumatic reticuloperitonitis or reticulopericarditis, which can culminate in heart failure and death. The diagram illustrates how both pathways ultimately converge on economic loss and, in severe cases, mortality.

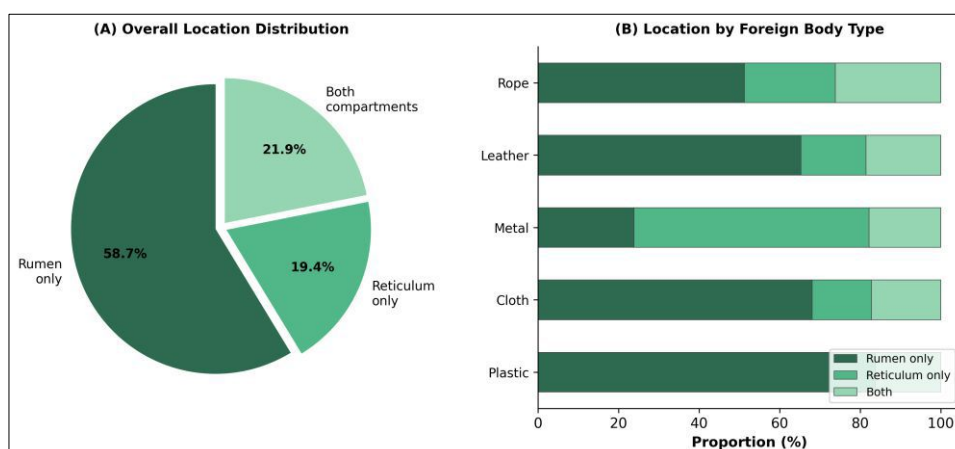


Fig 4: Anatomical distribution of foreign bodies: (A) overall location and (B) location stratified by foreign body type

Figure 4 shows that the rumen was the primary site of foreign body accumulation (58.7%), which is expected given its larger volume and capacity. Panel B breaks down

the location pattern by material type, revealing that metallic objects behaved differently from all other categories: 58.4% of metallic foreign bodies were found in the reticulum alone,

compared to only 11.3% to 22.6% for non-metallic types. This reflects the gravitational settling of dense metallic items into the reticulum's honeycomb-structured floor.

Comprehensive Interpretation

The results of this research reveal that foreign body ingestion in cattle at the Bedeno Woreda Municipal Abattoir is not only prevalent but also pathologically consequential. The 41.2% overall prevalence, combined with the finding that over two-thirds of affected animals exhibited mucosal damage, paints a picture of a problem that extends beyond simple contamination into active tissue injury. The dose-response relationship between foreign body mass and pathological severity suggests that early detection and environmental interventions could prevent progression from mild to severe disease. The synergistic interaction of age and body condition in driving prevalence means that the most vulnerable animals are those least able to compensate physiologically for the burden they carry.

Discussion

The 41.2% prevalence recorded in this research is comparable to rates reported by several other Ethiopian abattoir-based investigations but sits at the higher end of the spectrum. Negash and colleagues^[2] documented 34.2% at Ambo, while Tesfaye and co-workers^[5] reported 43.7% in the Haramaya District, a locality geographically proximate to Bedeno. The slightly elevated prevalence in the present research may reflect the rapid peri-urban expansion that Bedeno town has experienced, which has intensified waste generation and reduced the buffer zone between settlement areas and grazing lands^[14].

The dominance of plastic materials as the most common foreign body type mirrors findings across Ethiopia and other East African countries^[1, 6, 16]. Plastic bags are lightweight, widely distributed, and easily carried by wind onto pasture, making them the most accessible non-food item for grazing cattle. The Ethiopian government's 2007 regulation restricting thin plastic bag production and import has had limited practical effect in rural and peri-urban settings, where enforcement infrastructure remains weak^[17]. Interventions targeting plastic pollution at the community level, such as organized clean-up campaigns and incentives for biodegradable packaging, appear necessary to complement regulatory approaches.

The pathological findings add an important dimension to the existing literature. While most Ethiopian research on this topic has limited itself to prevalence and type characterization, this research demonstrates that a majority of positive cattle (67.6%) already exhibit macroscopic tissue changes. The correlation between foreign body weight and pathological severity is consistent with observations by Mushonga and colleagues^[11] in Rwanda, who noted that heavier ruminal loads were associated with more advanced mucosal erosion. The three cases suggestive of traumatic reticulopericarditis, though representing only 1.7% of positive animals, underscore the potentially fatal consequences of metallic foreign body penetration^[9, 10].

The age and body condition interactions shown in the heatmap analysis deserve particular attention. Older cattle in poor condition face a compounded risk, where the physiological demands of aging and nutritional stress combine with a longer cumulative exposure to contaminated environments^[8, 18]. This finding suggests that

supplementary feeding programs targeting older, emaciated animals during dry season months could serve a dual purpose: improving nutritional status and reducing the drive to scavenge on waste-contaminated land.

The research was limited by its cross-sectional design, which captures a single point-in-time snapshot rather than a longitudinal picture of foreign body accumulation. Additionally, histological examination was not performed, meaning that early microscopic changes may have been missed in animals classified as having no visible pathology. Future investigations incorporating histopathological analysis and ante-mortem diagnostic techniques such as reticular radiography would provide a more complete understanding of the progression from ingestion to clinical disease.

Conclusions

This research has documented that foreign body ingestion in cattle slaughtered at the Bedeno Woreda Municipal Abattoir is both prevalent, at 41.2%, and pathologically significant, with over two-thirds of affected animals exhibiting gross mucosal changes ranging from mild hyperemia to severe transmural inflammation and adhesion formation. The findings establish a clear link between the presence of indigestible materials in the ruminant forestomach and measurable tissue damage, thereby moving the discussion beyond prevalence statistics and into the realm of tangible animal welfare and productivity consequences.

The identification of plastic materials as the predominant foreign body type confirms that environmental pollution is the primary driver of this condition in the Bedeno area. Cattle grazing on contaminated communal lands ingest these materials not through any behavioral abnormality but simply because the waste is present in their foraging environment. Addressing this root cause demands a multi-stakeholder approach. Local government authorities should strengthen waste collection services and enforce existing regulations on plastic bag use. Community organizations can play a role by organizing regular grazing land clean-up events and by raising awareness among livestock keepers about the health risks associated with allowing cattle to scavenge near waste dumping sites.

The pathological consequence pathway documented in this research highlights the progressive nature of tissue damage. Animals that begin with mild mucosal irritation may, if exposure continues, advance to erosion, ulceration, and eventually transmural inflammation with adhesions that compromise digestive function irreversibly. This progression implies that early intervention, whether through environmental cleanup or through veterinary detection and management, can prevent the most severe outcomes. Routine abattoir monitoring, with systematic recording of both foreign body prevalence and associated pathological changes, would generate the longitudinal data necessary to track whether interventions are having their intended effect.

The strong influence of age and body condition on foreign body prevalence and pathological severity provides actionable information for targeted prevention. Older cattle in poor nutritional status are the most vulnerable subpopulation, and directing supplementary feeding resources toward these animals during the dry season could reduce their reliance on scavenging and, consequently, their exposure to foreign materials. Veterinary extension services should incorporate foreign body awareness into their regular

outreach activities, educating herders about the early signs of impaction, the dangers of metallic object ingestion, and the importance of maintaining cattle in adequate body condition throughout the year.

The discovery that metallic foreign bodies disproportionately accumulate in the reticulum and are associated with the most severe pathological outcomes, including reticulopericarditis, reinforces the need for specific measures targeting metallic waste. Improved disposal of construction debris, fencing wire, and discarded metal implements around grazing areas would reduce the availability of these particularly hazardous items. In settings where metallic contamination cannot be entirely prevented, the prophylactic use of reticular magnets in high-risk cattle could be explored as a supplementary protective measure.

In summary, the findings of this research underscore that the ingestion of indigestible foreign bodies by cattle in eastern Ethiopia is a problem with real and measurable consequences for animal health, welfare, and economic productivity. The data support a case for integrated interventions that combine environmental waste management, community education, targeted nutritional support for vulnerable animals, and strengthened abattoir surveillance systems. Without such coordinated action, the burden of foreign body-related morbidity and mortality in the cattle population of Bedeno Woreda and similar localities across the Horn of Africa will persist and likely worsen as urbanization and waste generation continue to grow.

Acknowledgements

Funding Sources

This research was funded through an internal research allocation from the Faculty of Veterinary and Animal Sciences, Hargeisa Metropolitan University. No external or commercial funding was involved.

Institutional Support

The authors appreciate the cooperation of the Bedeno Woreda Municipal Abattoir administration, the Bedeno District Livestock and Fisheries Office, and the laboratory support unit of Hargeisa Metropolitan University for facilitating data collection and analysis.

Contributions Not Qualifying for Authorship

The authors are grateful to the meat inspectors and abattoir staff at Bedeno Woreda Municipal Abattoir who assisted with sample handling and ante-mortem data recording. Mr. Jibril Dahir and Ms. Nasra Warsame contributed to data compilation and initial statistical tabulation but did not meet authorship criteria.

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