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PREVALENCE OF INDIGESTIBLE FOREIGN BODIES (IFBs) IN THE RUMEN AND RETICULUM OF SHEEP AND GOATS SLAUGHTERED AT KANO MAIN ABATTOIR, KANO STATE, NIGERIA

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ABSTRACT

A cross-sectional study was conducted at Kano Main Abattoir, Kano State, between November 2024 and February 2025 to evaluate the prevalence of indigestible substances in the rumen and reticulum of slaughtered small ruminants. The study examined 21,186 animals, comprising 5,488 sheep (ovine) and 15,698 goats (caprine), selected through a simple random sampling technique. During ante-mortem evaluation, data on gender, age, and body condition score (BCS) were recorded. Post-mortem examinations of the rumen and reticulum were performed to identify and document foreign materials in the gastrointestinal tracts. Out of the 3,828 animals examined, 300 (7.8%) were found to harbor various types of indigestible foreign materials. The prevalence was higher in sheep (8.1%) compared to goats (7.5%) ($\chi 2$=0.33, P>0.0001). Adult animals exhibited a significantly higher prevalence (12.8%) than younger ones (4.04%) (P<0.0001; $\chi 2$=51.4; OR=0.29). No significant difference was observed between males (6.7%) and females (8.1%) (P>0.0001; $\chi 2$=0.74; OR=0.82). Animals with poor BCS showed a higher prevalence compared to those with medium or good BCS. The study revealed that indigestible foreign materials were more frequently recovered from the rumen than the reticulum in both sheep and goats. Polythene bags (66.7%) were the most commonly encountered foreign material, followed by clothing items (24.3%), mosquito nets (6.7%), hair (2%), and nails (0.3%). Predisposing factors included inadequate plastic waste disposal systems, poor livestock management practices, and free grazing. To address these issues, collaborative intervention schemes involving government agencies and livestock farmers are recommended to raise public awareness about proper domestic waste disposal practices.

Keywords: Abattoir, Goat, Indigestible Foreign Bodies (IFBs), Kano, Prevalence, Reticulum, Rumen, Sheep

INTRODUCTION

Small ruminants, such as sheep and goats, play a vital role in the meat supply of tropical regions. Their importance is widely recognized, as reported by Saulawa *et al*. (2012). These animals are primarily raised for four main purposes: meat, milk, skin, and wool, in descending order of priority. Beyond these uses, they also provide valuable products like manure and hair, which have both nutritional and economic significance. The specific roles of small ruminants vary across different regions globally. Sheep are characterized as defenseless, tight-flocking ruminants with wool-covered bodies, adapted to grassland habitats in mountainous areas (Saulawa *et al*., 2012). In contrast, goats are naturally inclined to inhabit mountainous terrains and typically form herds of five to twenty individuals. These animals are highly selective feeders and tend to consume a greater proportion of indigestible substances compared to cattle (Hailat *et al*., 1997). This behavior is more pronounced during periods of drought or food scarcity (Igbokwe *et al*., 2003; Rabana *et al*., 2022). The ingestion of indigestible materials is exacerbated by poor environmental sanitation and the lack of recycling industries in many areas. The indiscriminate disposal of non-biodegradable materials such as polythene bags and nylon sheets make it easy for free-grazing small ruminants to ingest these items (Ghurashi *et al*., 2009).

In Nigeria, the demand for sheep and goats is notably high due to their use in rituals, religious sacrifices, and cultural festivals. This demand has created employment opportunities for livestock farmers and contributed to national income growth (Anyanwu *et al*., 2016). However, several factors hinder the productivity of ruminants in Nigeria, including disease risks, inadequate breeding strategies, poor management systems, weak husbandry practices, and suboptimal feeding conditions (Lawal-Adebowale, 2012). Ruminants are particularly prone to ingesting non-dietary foreign materials (Asrat *et al*., 2015; Ali and Awoke, 2019). This behavior is often linked to malnutrition or unbalanced diets that result in nutritional deficiencies and pica—a condition characterized by the consumption of non-food items (Ghurashi *et al*., 2009; Saulawa *et al*., 2012; Jebessa *et al*., 2018; Amin and Fentahun, 2020). Over time, this can lead to severe complications in various organs, particularly the rumen and reticulum (Mozaffari *et al*., 2009; Teshome *et al*., 2017). The susceptibility of sheep and goats to ingesting foreign materials has become a significant global issue in livestock production systems within developing countries. Environmental contamination exacerbates this problem. Rumen and reticulum impactions caused by indigestible foreign bodies are among the most critical veterinary emergencies reported in regions lacking proper waste recycling facilities (Tesfaye *et al*., 2012a). Free grazing in urban and suburban areas further increases the risk (Fasil, 2016).

Indigestible materials ingested by small ruminants often accumulate in the rumen or reticulum, disrupting normal fermentation processes and content mixing within these organs, leading to indigestion. In severe cases, such materials can obstruct the orifice between the reticulum and omasum or

cause life-threatening complications if not surgically removed (Abdelaal and EL-Maghawry, 2014; Rabana *et al.*, 2022). These foreign bodies cannot be digested or excreted through feces (Mohammed, 2012), posing significant health hazards to affected animals. The presence of foreign objects in the rumen and reticulum can disrupt the effective absorption of volatile fatty acids, thereby hindering weight gain (Igbokwe *et al*., 2003). Despite the significance of this issue, there is limited data on the prevalence of impaction caused by indigestible foreign materials in small ruminants within Kano State.

This study aims to address this gap by examining the occurrence and types of indigestible foreign bodies (IFBs) found in the rumen and reticulum of sheep and goats slaughtered at Kano Main Abattoir, located in Kano State, Nigeria.

MATERIALS AND METHODS

Study Area

The Kano Main Abattoir is situated within the ancient city gate of Mazugal (Kofar Mazugal) in the Fagge Local Government area of Kano State. Its GPS coordinates are 12.018^{0}N and 08.521^{0}E. This abattoir is renowned for its large-scale slaughtering of camels, cattle, sheep, and goats, primarily sourced from both within and outside Nigeria (Garba *et al*., 2022).

Kano is located in the North-West geopolitical zone of Nigeria. The state was established on May 27, 1967, from the defunct Northern Region. Historically, Kano dates back to the 7th century AD, when migrants arrived in search of iron ore to manufacture farming tools. Kano State comprises 44 local governments and spans a land area of 20,131 km², with an estimated population of 11,056,300 according to the 2011 census. The capital city is Kano, which borders Katsina State to the northwest, Jigawa State to the northeast, Bauchi State to the southeast, and Kaduna State to the southwest. Originally, Jigawa State was part of Kano, until it became a separate state in 1991. The predominant indigenous ethnic group is Hausa, although other groups such as Yoruba and Fulani are also present (NPC, 2006). Kano metropolis is the second main industrial and commercial center in Nigeria after Lagos and it's an educational nerve center comprised of many tertiary institutions (Garba and Yahya, 2025).

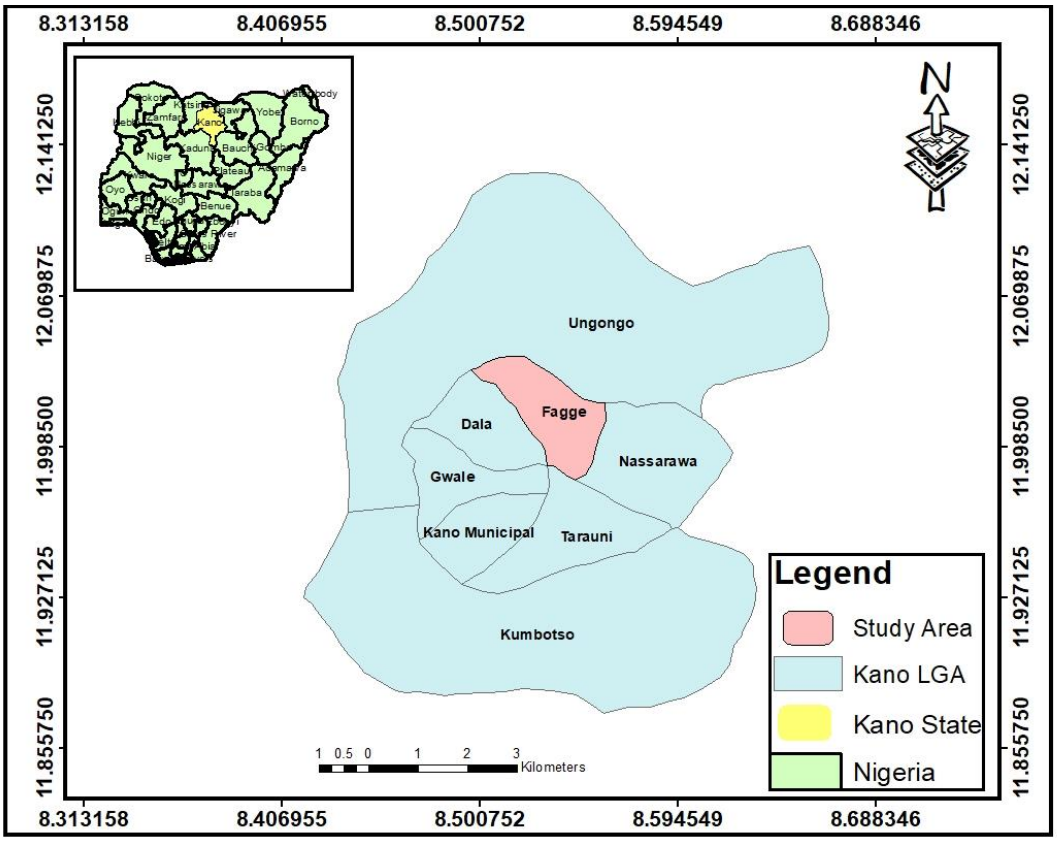

Figure 1: Map of Kano State Showing the Study Area (Source: Garba *et al*., 2022)

Study Design

This cross-sectional study employed a convenience sampling technique to examine the rumen and reticulum of sheep and goats at the Kano Main Abattoir. The study aimed to determine the frequency and types of indigestible foreign bodies consumed by these small ruminants. According to the data collected, the sheep and goats transported for slaughter at the abattoir originated from Kano city, neighbouring states, farms, markets, and households that primarily used extensive management systems. Nearly all the small ruminants slaughtered were local breeds, including Yankasa, Ouda, Balami sheep, as well as Sokoto Red, Sahelian, and West African Dwarf goats.

Sampling Procedure

The sampling took place from November 2024 to February 2025, targeting goats and sheep presented for slaughter at the abattoir. Over the 120-day study period, a total of 5,488 sheep and 15,698 goats were slaughtered at Kano Main Abattoir. For the study, a systematic random sampling technique was used to select a total of 3,282 small ruminants.

Ante-mortem Examination and Evaluation of Parameters

A comprehensive pre-slaughter antemortem examination was conducted for all animals. This assessment included vital parameters such as body temperature, respiratory rate, heart rate, and rumen motility. Additionally, the species, gender, age (categorized into two groups: young animals under one year and adults over one year), and body condition score (BCS) of each animal were meticulously observed and recorded. The age determination was based on dental eruption and wear patterns of incisor teeth, following established methods (Pace and Wakeman, 2003). The BCS was evaluated by assessing the animal's physical appearance and manually palpating muscle and fat deposits around the lumbar vertebrae and transverse processes, consistent with guidelines outlined by Thompson and Meyer (1994).

During each visit to the selected abattoirs, a daily sample of 20 small ruminants was chosen for slaughter, irrespective of species, gender, or age, until the desired sample size was achieved. Research assistants at the abattoir labeled the selected animals and closely monitored them throughout the slaughter process. To ensure accurate data collection, vital parameters such as body temperature, respiratory rate, heart rate, and rumen motility were carefully examined for each selected animal.

Post-mortem Evaluation

Following slaughter, the rumen and reticulum were incised, flayed, eviscerated, and physically examined for the presence or absence of indigestible foreign materials. Subsequently, any recovered foreign materials were carefully removed from the abdominal cavity (rumen, reticulum, or both). The foreign bodies observed were identified, washed, dried, and recorded for each fore-stomach (rumen, reticulum, or both) in each goat or sheep examined. The isolated indigestible foreign bodies (IFBs) were categorized into metallic objects, polythene bags, rags, ropes, sack threads, and fruit seeds, consistent with the classification described by Alemneh *et al*. (2017). The ruminal content was weighed in kilograms (kg) for the whole rumen. The total weight of the rumen varied: for adult sheep, it ranged from 2 to 4 kg, and for young sheep, it was between 0.5 and 1.5 kg. For goats, the range was 1.5 to 3.5 kg for adults and 0.3 to 1.2 kg for young animals. To separate non-degradable materials, they were floated in water and sieved. The weight of these materials was determined as indigestible. Finally, the weight of the empty rumen was calculated by subtracting the weight of the rumen contents (both digestible and indigestible) from the total weight of the whole rumen with its contents.

Data Analysis

GraphPad Prism software (version 6.0, GraphPad Software Inc., California, USA) was utilized for statistical analysis in this study. The relationships between categorical variables—such as age, gender, body condition score (BCS), and season—and the presence of indigestible foreign materials were assessed using the Chi-square ($\chi 2$) test. Statistical significance was defined as a P*P*-value less than 0.05. The prevalence and types of indigestible foreign materials were expressed as percentages to provide a clear representation of the findings.

RESULTS AND DISCUSSION

Results

Table 1 provides an overview of the prevalence of indigestible foreign bodies in small ruminants slaughtered at Kano Main Abattoir, located in Kano State, Nigeria. A total of 3,828 small ruminants, including 1,513 goats and 2,315 sheep, were examined for the presence of indigestible foreign materials in their fore-stomachs. The study identified 300 cases (7.8%) of foreign body impaction. Specifically, 113 goats (7.5%) and 187 sheep (8.1%) were affected by these materials. Statistical analysis revealed no significant correlation (P>0.0001) between the type of ruminant (goats versus sheep) and the prevalence of indigestible foreign materials.

Table 1: Prevalence of Indigestible Foreign Bodies in Small Ruminants Slaughtered at Kano Main Abattoir, Kano State, Nigeria

Specie	No. Examined	No. Affected (%)	Prevalence (%) (95% CI: LL-UL)	χ^2	P-value	OR
Goats	1513	113 (7.5)	7.5[a] (6.25-8.76)	0.33	0.564	0.92
Sheep	2315	187 (8.1)	8.1[a] (7.06-9.14)			
Total	3828	300 (7.8)	6.93-8.74			

Key: [a]Similar superscripts indicate no significant ($P > 0.05$) difference in prevalence;
$\chi 2$ = Chi-square; CI = Confidence Interval; LL = Lower limit; UL = Upper limit

Table 2 clearly illustrates the various types of foreign bodies encountered during this study. Polythene was the most prevalent, accounting for 66.76% of the total, followed by clothing at 24.3%, and then mosquito nets at 6.7%. Hair and nails were found in smaller quantities, representing 2% and 0.3%, respectively.

Table 2: Shows the Different Type of Indigestible Foreign Bodies Found in the slaughtered Small Ruminants at Kano Main Abattoir, Kano State, Nigeria

Species	Polythene	Mosquito net	Hair	Nail	Clothes
Ovine	82	11	4	1	15
Caprine	118	9	2	0	58
Total (%)	200(66.7%)	20 (6.7%)	6 (2%)	1 (0.3%)	73 (24.3%)

Table 3 presents findings on risk factors linked to the presence of indigestible foreign bodies in small ruminants slaughtered at Kano Main abattoir, Kano State. Out of a total of 1015 young and 2813 adult small ruminants examined, cases of indigestible foreign bodies were significantly more prevalent in adults (N=359, 12.8%) compared to young animals (N=41, 4.04%). Statistical analysis revealed a strong association between age and the prevalence of foreign body ingestion (P<0.0001), with an odds ratio (OR) of 0.029, indicating that younger ruminants are considerably less likely to ingest

indigestible materials than their adult counterparts. Additionally, gender-based observations showed that among 687 male and 3141 female small ruminants examined, females exhibited a higher prevalence of indigestible foreign bodies (254 cases, 84.6%) compared to males (46 cases, 15.3%), with prevalence rates of 8.1% and 6.7%, respectively. However, statistical analysis indicated no significant correlation between gender and the occurrence of foreign body ingestion (P>0.0001). The calculated OR of 0.82 suggests that male goats and sheep are less likely to consume indigestible materials than females.

Table 3: Some Risk Factors Associated with the Occurrence and Prevalence of IFBs in Small Ruminants Slaughtered at Kano Main Abattoir, Kano State, Nigeria

Risk Factors	Parameters	No. Examined N=3828	No. Affected (%)	Prevalence (%) (95% CI: LL-UL)	χ^2	P-value	OR
Age	Young (<1 year)	1015	41 (4.04)	2.53[a] (2.96-5.49)	51.4	<0.0001	0.29
	Adult (>1 year)	2813	359 (12.8)	2.47[b] (11.57-14.04)			
Sex	Male	687	46 (6.7)	3.8[a] (5.05-8.85)	0.74	0.39	0.82
	Female	3141	254 (8.1)	1.95[a] (7.17-9.12)			

Key: N = Total number of small ruminants examined and sampled during study period;
[a,b] Different superscripts indicate significant (P<0.05) difference in prevalence;
$\chi 2$ = Chi-square; OR= Odd Ratio

Table 4 shows the prevalence of indigestible foreign bodies in small ruminants slaughtered at Kano Main abattoir Kano state based on BCS. Out of 763, 477 and 273 sheep examined with poor, medium, and good BCS, 61, 30, and 22 cases were found to have indigestible foreign materials with prevalence rates of 8%, 6.3%, and 8.1% respectively. BCS was not significantly (P>0.0001) correlated with the frequency of indigestible foreign materials in sheep in Kano state. Moreover, out of 1123, 738, and 454 goats examined with poor, medium, and good BCS, 103, 51, and 33 animals were found to have indigestible foreign materials with prevalence rates of 9.2%, 6.9%, and 7.3%, respectively. BCS had no significant (P>0.0001) correlation with the prevalence of indigestible foreign bodies in goats in Kano state.

Table 4: Occurrence of Indigestible Foreign Bodies (IFBs) in Small Ruminants based on Body Condition Score (BSC) Levels in Kano State, Nigeria

Ruminant Type	BCS Level	No. Examined N=3828	No. Affected (%)	Prevalence (%) (95% CI: LL-UL)	χ^2	P-value	DF
Sheep	Poor	763	61 (8)	(6.26-10.15)	1.92	0.38	2
	Medium	477	30 (6.3)	(4.43-8.88)			
	Good	273	22 (8.1)	(5.37-11.91)			
Goats	Poor	1,123	103 (9.2)	(7.62-11.00)	3.56	0.17	2
	Medium	738	51 (6.9)	(5.30-8.97)			
	Good	454	33 (7.3)	(5.22-10.03)			

Key: $\chi 2$ = Chi-square; CI = Confidence Interval; LL = Lower limit; UL = Upper limit
N = Total number of small ruminants examined and sampled during study period;
n = Total number of small ruminants found with indigestible foreign materials
DF = Degree of Freedom

Discussion

The ingestion of indigestible substances by small ruminants is a widespread issue reported globally, including in Nigeria (Igbokwe *et al*., 2003; Remi-Adewunmi *et al*., 2004; Rabana *et al*., 2022), Jordan (Hailat *et al*., 1997), and Sudan (Ghurashi et al., 2009). Foreign materials such as polythene, rope, cloth, metal, hair, and other non-digestible items pose significant health risks and economic losses to free-grazing animals (Abebe and Nuru, 2011). This study examined the prevalence of indigestible foreign bodies in small ruminants slaughtered at Kano main abattoir, Kano State. Results indicated that clothes and polythene were less frequently found in sheep compared to goats. Conversely, sheep exhibited a higher prevalence of rumen indigestible substances than goats, likely due to goats' selective grazing behavior (Remi-Adewunmi *et al*., 2004). Female animals showed a higher prevalence of foreign body ingestion compared to males. The ingestion of such materials is often linked to forage shortages and increased pollution of grazing areas (Negash *et al*., 2015). In Nigeria, feed scarcity during prolonged dry seasons exacerbates this issue, as most small ruminant owners rely on extensive management practices without supplementary feeding (Rabana *et al*., 2022). The study revealed that goats were significantly more prone to consuming indigestible foreign materials than sheep in the surveyed area. This aligns with findings from Mohammed (2012) and Negash *et al.* (2015), who also reported higher frequencies of foreign body ingestion in goats. Additionally, Abebe and Nuru (2011), Tesfaye *et al.* (2012b), Saulawa *et al*. (2012), and Otsyina *et al*. (2015) observed no significant differences between sheep and goats regarding foreign body prevalence. Variations in findings may be attributed to differences in the origins of sampled ruminants or disparities in access to waste materials from domestic or industrial sources.

This study found no statistically significant association between species differences and the ingestion of foreign substances (p>0.05). In contrast, Roman and Hiwot (2010) and Hailat *et al.* (1997) reported significant associations

between species differences and foreign body ingestion. Such discrepancies could stem from variations in feeding systems or seasonal forage availability. Feed shortages during specific periods often lead animals to consume atypical materials such as plastic, cloth, rope, or metal due to energy imbalances caused by inadequate nutrition (Rabana *et al*., 2022). This study reveals that female animals are more likely to ingest non-digestible foreign bodies than males, a finding consistent with earlier research (Teshome *et al*., 2017; Rabana *et al*., 2022). This outcome may be attributed to the increased appetite and nutritional demands of female animals during lactation, estrus, hormonal changes, and pregnancy. Additionally, the gradual consumption of non-digestible materials over extended periods suggests that the higher prevalence in females could be linked to their prolonged presence at farm sites for breeding purposes (Hailat *et al*., 1997). However, some studies have reported contradictory findings (Abebe and Nuru, 2011; Saulawa *et al*., 2012). The current study also indicates that animals aged three years or older are more vulnerable to the impacts of ingesting non-digestible foreign bodies compared to those in the 1–2 year age group, followed by those under one year. The youngest group had the lowest percentage of plastic bags in their rumen and reticulum, aligning with previous studies (Teshome *et al*., 2017; Rabana *et al*., 2022). A higher prevalence of rumen foreign bodies was observed in goats and sheep with poor body conditions, similar to earlier findings (Remi-Adewunmi *et al*., 2004; Saulawa *et al*., 2012; Teshome *et al*., 2017). Poor body condition and the presence of rumen foreign bodies were attributed to interference with abdominal distention, lack of defecation leading to emaciation and recumbency, inappetence due to the rumen's absorption of volatile fatty acids, and reduced weight gain (Igbokwe *et al*., 2003).

Ruminal impaction is a condition characterized by the accumulation of feed material, typically dry or fibrous, in the rumen of ruminant animals. This accumulation can obstruct normal rumen function and lead to various signs and symptoms, including decreased appetite, decreased or absent rumen contractions, distended abdomen, decreased or absent fecal output, abdominal discomfort, dehydration, and dullness (Rabana *et al.*, 2022). Non-digestible foreign bodies often become trapped in the honeycomb structure of the reticular mucosa, found in the reticulum's lumen due to the gravitational pull of heavy foreign materials towards the ventral part of the forestomach (Rabana *et al.*, 2022). The widespread use and improper disposal of items like clothing, mosquito nets, and polythene bags used for packaging goods could contribute to the occurrence of foreign bodies in the rumen and reticulum. Lack of awareness among livestock owners about the risks of ingesting these materials by small ruminants may also play a role (Rabana *et al*., 2022). Feed shortages typically occur at specific times of the year in many tropical countries, and most owners do not provide supplementary feed, particularly for sheep and goats. Furthermore, not all small ruminants brought for sale in this study are destined for abattoirs; many may be sold to individuals who slaughter them at home during sacrifices, ceremonies, and festivals (Rabana *et al.*, 2022). The present study's results are limited to animals slaughtered at the Kano Main abattoir, which might have contributed to the relatively lower prevalence rate of indigestible foreign materials in sheep and goats. Our findings align with those of Ghurashi *et al*. (2009) in Sudan and Tesfaye *et al*. (2012b) in Ethiopia, who identified insufficient forage land available for grazing in urban and peri-urban areas as a major factor exposing sheep and goats to a high risk of ingesting indigestible foreign materials.

The prevalence of indigestible foreign materials in sheep and goats was correlated with age in this study. The findings revealed that the consumption of indigestible foreign materials is significantly less likely to occur in young goats and sheep compared to adults. This might be partly due to the gradual ingestion of indigestible foreign materials over sustained periods as the animal grows older. Moreover, older animals meet their trace mineral demands through feed, whereas younger animals acquire their nutrient requirements from milk. This result is consistent with similar studies by Remi-Adewunmi *et al.* (2004), Roman and Hiwot (2010), Abebe and Nuru (2011), Saulawa *et al*. (2012), Tesfaye *et al*. (2012b), Fasil (2016), Mekuanint *et al*. (2017) and Rabana *et al.* (2022), who reported a higher prevalence of indigestible foreign bodies in adults than in young ruminants. However, these findings contradict Otsyina *et al.* (2015), who found a significantly higher prevalence of foreign bodies in young sheep and goats than in adults. Akinrinmade and Akinrinde (2013) noted that sheep and goats are typically exposed to the consumption of indigestible materials at an early age, and accumulation occurs over time due to increased environmental pollution.

CONCLUSION

Ingestion of foreign bodies by sheep and goats constitutes a significant pathological condition with both economic and health implications. The high prevalence of this issue may be attributed to inadequate environmental management and pollution with indigestible materials such as polythene, plastic, and other non-digestible items. During dry seasons, the scarcity of forage and nutritional deficiencies prompt animals to graze in potentially polluted areas, exposing them to various indigestible materials, including plastics, clothing, ropes, leather, and metals. The widespread use and improper disposal of plastic bags, coupled with a lack of effective legislation and awareness campaigns regarding waste management and small ruminant health, have contributed to the high incidence of rumen impaction with indigestible foreign materials in these animals. This study highlights that plastic/nylon (polyethylene) bags are among the most common indigestible foreign materials found in small ruminants. The findings of this observational study underscore the importance of foreign bodies as a risk factor for health and productivity issues, leading to weight loss by interfering with the absorption of volatile fatty acids, mortality, and premature culling. This research can inform environmental activists, livestock owners, veterinarians, and policymakers about the impact of indigestible foreign materials on the health and productivity of ruminants in Kano State, Nigeria, thereby supporting efforts to mitigate these issues.

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