Prevalence of indigestible foreign bodies and its associated potential risk factors in rumen and reticulum of domestic ruminants at Bishoftu Elfora Export Abattoir

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Abstract

Background: Nowadays ingestion of indigestible foreign bodies poses serious economic loss to domestic ruminants, especially in a developing country.

Objectives: The study aims to determine the prevalence of indigestible foreign bodies in the forestomach of domestic ruminants slaughtered at Bishoftu Elfora Export Abattoir and its associated potential risk factors and identify the location and type of these indigestible foreign bodies.

Study animals: On 384 domestic ruminants (171 goats, 125 sheep and 88 cattle) presented for slaughter from different zones of the region.

Methods: Cross-sectional study design was conducted from May 2021 to September 2021. Each animal was subjected to ante-mortem and post-mortem inspection by providing a unique identification number. For post-mortem examination, the forestomach was carefully removed from the abdominal cavity. For the positives, the location was properly recorded, washed, identified and photographed.

Results: The overall prevalence of indigestible foreign bodies in domestic ruminants was 30.73% (118/384). Of these, 32.75% (56/171), 28% (35/125) and 30.68% (27/88) were recorded in goats, sheep and cattle, respectively, without statistically significant difference ($p > 0.05$). Aged domestic ruminants 39.3% (33/84) had poor body conditions 38.98% (23/59), originated from the Borena zone 42.11% (16/38) and were relatively recorded with higher prevalence. From the forestomach compartments, the indigestible foreign bodies were majorly found in rumen 86.43% (102/118) and reticulum 13.56% (16/118) with a statistical difference ($p < 0.05$).

Conclusion and clinical importance: Ingestion of indigestible foreign bodies mainly during the dry season due to shortage of forage, less biodegradable and negligent waste disposal like plastic bags attribute environmental and animal health problems and pose loss to the national economy.

Keywords
cattle, export abattoir, foreign bodies, goats, prevalence, sheep
1 | INTRODUCTION

Ethiopia has the largest livestock population potential in Africa, with about 33 million goats, 61 million chickens, over 31 million sheep and 63 million cattle (Birhanu, 2019). The country has great livestock production potential, both for local consumption and export purpose, but is underexploited due to limited natural and commercial feeds, various diseases, limited exploitation of genetic potential and inaccessible livestock marketing and processing (Guadu & Abebaw, 2016). Besides, livestock’s economic potential has been diminished by the dense population of animals in certain areas such as highlands and the frequent maintenance of cattle for status and reputation (Gizachew, 2002). Ruminants are crucial to countries’ economic besides providing meat, milk, drought resilience, revenue and draught purpose; however, the contribution of these domestic ruminants falls short due to poor management systems and other diseases (Herrero et al., 2013). One of the diseases is due to ingestion of indigestible foreign bodies, which poses serious economic loss in terms of decreased production, productivity and a high death rate, especially in developing countries (Teshome et al., 2017). It is most of the time asymptomatic and only clinically diagnosed in live animals if the material is accumulated in large amounts albeit adequately studied in abattoirs (Farooq et al., 2020).

Cattle are more susceptible to ingestion of indigestible foreign bodies than small ruminants due to less use of their lips for prehension, and this lack of oral discrimination may predispose them to foreign bodies that would be rejected by other species (Anwar et al., 2013). Ingestion of indigestible foreign materials is also related to ruminant nutritional deficiencies, contamination and inadequate feeding management, as well as a range of rumen and reticulum problems (Amin & Fentahun, 2020). Not only these but also during drought season and food shortages, sheep and goats can consume huge amounts of indigestible materials such as plastic, leather and metal and these may be present in ruminants reared in urban and suburban environments (Khose et al., 2010; Tiruneh & Yesuwork, 2010). Besides, the ingestion is also often linked to environmental contamination owing to the lack of recycling businesses, environmental cleaning practices and inappropriate disposal of plastic bags and free-grazing animals, particularly in towns and villages (Rana & Negi, 2018).

The ingestion of indigestible foreign bodies can lead to impaction and distension of the rumen and consequently cause a lack of defecation by interfering with the passage of ingesta. In addition, the foreign bodies entering and migrating through animal tissues can cause a variety of complications, which vary depending on the type of the foreign body and how it enters the tissues (Christensen, 2009). For instance, traumatic reticulo peritonitis develops due to perforation of the wall of the reticulum and allows leakage of ingesta and normal microflora contaminating the peritoneal and pleural cavity resulting in local or diffused peritonitis, pleuritis, pneumonitis and pericarditis (Akkoc, 2007; Gokce et al., 2007).

In Ethiopia, there are few and limited findings regarding the magnitude and occurrence of indigestible foreign bodies in the forestomach of domestic ruminants and their associated potential risk factors. Furthermore, the type and location of these foreign bodies were not further explored and documented in various ruminant species. Therefore the objectives of this study are:

1. To determine the prevalence of indigestible foreign bodies in the forestomach of domestic ruminants slaughtered at Bishoftu, Elfora Export Abattoir, and its associated potential risk factors;
2. To identify the location and type of these indigestible foreign bodies.

2 | MATERIALS AND METHODS

2.1 | Study area

The study was carried out at Bishoftu town (Figure 1), Elfora Export Abattoir, from May 2021 to September 2021. The slaughterhouse is located in the town; far 47 km south of Addis Ababa (Mekibib et al., 2019), at 9°N latitude and 40°E longitudes, at a height of 1850 m above sea level. The region receives 1151.6 mm of annual rainfall, with 84% of that falling during the long rainy season (June to September). From October through February, the dry season lasts. The typical annual maximum and lowest temperatures are 26 and 14°C, respectively, with a 61.3% relative humidity level (Bedasa et al., 2018).

The slaughterhouse has sufficient drinking water, a quality water supply and an electric power supply. There are also various facilities to perform some slaughterhouse procedures (irrigation systems, sanitary conditions, channel storage and cooling facilities, waste disposal systems, collection methods, etc.). The slaughterhouse exports mutton, goat meat and their edible internal organs (liver, kidneys and other organs) to Middle Eastern countries (Dubai and Arab; Mummed, 2015).

2.2 | Study animal

The study was conducted on 384, apparently healthy and slaughtered, domestic ruminants at Bishoftu, Elfora Export Abattoir, from May 2021 to September 2021. The animals were all-male local breeds, which originated from various zones of the region such as East Bale, Borena, West Arsi and East Shoa. They were transported to the abattoir using vehicles and on foot.

2.3 | Study design

A cross-sectional study was conducted from May 2021 to September 2021 at Bishoftu, Elfora Export Abattoir, to estimate the prevalence and identify types of indigestible foreign bodies ingested by domestic ruminant animals and their associated risk factors. During the study, origin, age, body condition score, species, type of foreign bodies, location and nature of identified foreign bodies were considered as risk factors.
2.4 | Sample size determination and sampling technique

There was no previous study on the occurrence of foreign bodies in the forestomach of goats, sheep and cattle slaughtered at the Bishoftu Elfora Export Abattoir. Thus, by the rule of thumb, where there is no information for an area, it is possible to take 50% expected prevalence. In this study, 50% prevalence with 5% desired level of precision and 95% of the confidence interval is used to calculate the sample size using the following formula as described by Thrusfield (2005).

\[ n = \frac{(1.96)^2 \times \text{P}_{\text{expected}} \times (1 - \text{P}_{\text{expected}})}{d^2}, \]

where \( n \) is the required sample size, \( \text{P}_{\text{expected}} \) is the expected prevalence and \( d \) is the desired absolute precision. The sample size for this work was determined using 50% expected prevalence and 5% absolute precision at a 95% confidence level.

Thus, \[ n = \frac{(1.96)^2 \times (0.05) \times (1 - 0.05)}{(0.05)^2} = 384 \]

Therefore, 384 domestic ruminants were sampled by purposive sampling.

2.5 | Study method

2.5.1 | Ante-mortem examination

Before undergoing post-mortem examination, animals presented for slaughter were subjected to ante-mortem inspection upon arrival at the abattoir to assess any changes in vital parameters and signs of disease both at rest and in motion on the premises (Food Agricultural Organization, 2009). During the inspection, individual animals were assessed and recorded in terms of age, breed, origin and physical condition. The age of the animals was determined based on dental eruption as described by Gatenby (2002) for sheep, cattle and goats, respectively, as young (< 5 years), adult (5–10 years) and old (10 years). Those who have not erupted permanent incisor teeth were classified as young, those with one or two pairs were classified as adults and more than two permanent incisor teeth were classified as old. Body condition was also graded as poor, medium and well based on the animal’s appearance and manual palpation of the spines and transverse processes of the lumbar vertebrae as described by McCurrin and Basser (2006). Furthermore, only animals that were judged to be sufficiently rested and normal were proceeding to slaughter, and each selected animal for the study was further identified by providing a unique identification number that would be used for the next post-mortem examination and findings. Thus, each animal leaves an imprint for identification by printing a code on its gluteal muscle with permanent ink.

2.5.2 | Post-mortem examination

In the post-mortem examination, the stomach of each animal was carefully removed from the abdominal cavity, and the compartment was thoroughly inspected by visual inspection and palpation before opening and exploring for any indigestible foreign bodies. For the existence of foreign substances, all of the contents were extensively inspected and explored. Later, the location and types of foreign bodies that were found in the stomach were properly recorded. For the positive forestomach compartment with foreign bodies, it
was removed, washed, identified in terms of location and type and photographed.

### 2.6 Data management and analysis

Data were entered into a Microsoft Excel spreadsheet and summarised using descriptive statistics. For analysis, SPSS Microsoft software Version 20.0 was used. Descriptive statistics were used to provide basic information about variables in a dataset and to highlight potential relationships between variables. Besides, the Pearson chi-square ($\chi^2$) test was also employed to assess the existence of an association between the prevalence of the foreign bodies and different potential risk factors considered. $p$-values less than 0.05 were considered significant. Finally, the results were displayed in the form of tables.

### 3 RESULTS

During the study, different foreign bodies were identified (Figure 2) and recorded, and the overall prevalence of indigestible foreign bodies in domestic ruminants was 30.73% (118/384). During the study, the prevalence of indigestible foreign bodies concerning the potential risk factors was also further assessed and recorded.

#### 3.1 Animal species

Of the total of 384 different ruminant animal species (171 goats, 125 sheep and 88 cattle) examined for the presence of indigestible foreign bodies, 118 (30.73%) were found positive for various forms of indigestible foreign bodies in their stomach compartments, mainly rumen and reticulum. Among the positives, relatively the highest was recorded in goats 32.75% (56/171), while the least was recorded in sheep with 28.00% (35/125; Table 1).

#### 3.2 Age groups

During the study, the prevalence of the indigestible foreign bodies in the different age groups of every ruminant was assessed. Accordingly, the higher number of positives were recorded in older animals.
TABLE 1 Prevalence of indigestible foreign bodies in slaughtered goats, sheep and cattle

| Species | Number examined | Number of positive animals | Prevalence (%) | Chi-square (χ²) | p-value |
|---------|-----------------|---------------------------|----------------|----------------|---------|
| Goat    | 171             | 56                        | 32.75%         | 0.765          | > 0.05  |
| Sheep   | 125             | 35                        | 28.00%         | –              | –       |
| Cattle  | 88              | 27                        | 30.68%         | –              | –       |
| Total   | 384             | 118                       | 30.73%         |                |         |

TABLE 2 Prevalence of indigestible foreign bodies in different age groups of domestic ruminants

| Factor | Level of factor | Animal examined | Positive for foreign bodies | Prevalence (%) | χ² | p-value |
|--------|-----------------|-----------------|----------------------------|----------------|----|---------|
| Age    | Old             | 84              | 33                         | 39.3%          | 4.282 | > 0.05  |
|        | Young           | 127             | 39                         | 30.71%         | –   | –       |
|        | Adult           | 173             | 46                         | 26.59%         | –   | –       |
| Total  |                 | 384             | 118                        | 30.73%         |     |         |

TABLE 3 Prevalence of foreign bodies concerning animal body condition score in different domestic ruminants

| Body condition score | No of animal examined | Animals with foreign bodies | Prevalence (%) | χ²    | p-value |
|----------------------|-----------------------|-----------------------------|----------------|-------|---------|
| Poor                 | 59                    | 23                          | 38.98%         | 2.723 | > 0.05  |
| Medium               | 117                   | 37                          | 31.62%         | –     | –       |
| Good                 | 208                   | 58                          | 27.88%         | –     | –       |
| Total                | 384                   | 118                         | 30.73%         |       |         |

 (> 10 years) at 39.3% (33/84) followed by young animals (< 5 years) at 30.71% (39/127) and the least in adult animals (5–10 years) 26.59% (46/173) without statistically significant difference (p > 0.05) as shown in Table 2.

3.3 | Body condition scores

Besides, the prevalence of different indigestible foreign bodies in different body condition scores of domestic ruminants was assessed. Accordingly, about 38.98% (23/59), 31.62% (37/117) and 27.88% (58/208) of the poor, medium and good body conditioned ruminants were found positive respectively without a statistically significant difference (Table 3).

3.4 | Origin

The cattle, sheep and goats that came from different zones of the region including West Arsi, East Bale, Borena and East Showa and slaughtered at Bishoftu Elfora Abattoir were also assessed for it. Accordingly, the highest frequency of indigestible foreign bodies was observed in animals coming from Borena 42.11% (16/38), followed by Bale 33.33% (19/57), while the lowest was recorded in domestic ruminants that came from West Arsi 27.86% (56/201) similarly without any statistically significant difference (Table 4).

3.5 | Types of identified indigestible foreign bodies in different animal species

During the study period, various types of indigestible foreign bodies like plastic, cloth, leather, sack and metals were identified from parts of the stomach of domestic ruminants. Of the foreign bodies, about 17.54% (30/171) and 12.8% (17/125) were found to be plastic materials in goats and sheep, respectively. On the other hand, many types of indigestible foreign bodies were identified in the stomach compartments of cattle. Among these were plastic 13.64% (12/88), cloth 12.5% (11/88), leather 1.04% (4/88), sack 5.68% (5/88) and metal 10.23% (9/88; Table 5).

3.6 | Location of identified indigestible foreign bodies

Of 118 positive cases recorded for various indigestible foreign bodies, about 86.44% (102/118) were identified in the rumen, while the rest 13.56% (16/118) were found in the reticulum with a statistical
TABLE 4  Prevalence of indigestible foreign bodies in relation to their origin of domestic ruminants

| Zone         | No. of animal examined | Number of positive animals for foreign bodies | Prevalence (%) | $\chi^2$ | p-value |
|--------------|------------------------|-----------------------------------------------|----------------|---------|---------|
| Borena       | 38                     | 16                                            | 42.11%         | 3.27    | >0.07   |
| East Bale    | 57                     | 19                                            | 33.33%         | –       | –       |
| East Shewa   | 88                     | 27                                            | 30.68%         | –       | –       |
| West Arsi    | 201                    | 56                                            | 27.86%         | –       | –       |
| Total        | 384                    | 118                                           | 30.73%         |         |         |

TABLE 5  Types of indigestible foreign bodies recorded among domestic ruminant species

| Species | Number examined | Plastic (%) | Cloth (%) | Leather (%) | Sack (%) | Metallic (%) |
|---------|-----------------|-------------|-----------|-------------|----------|--------------|
| Goat    | 171             | 30 (17.54)  | 9 (5.26)  | 5 (2.9)     | 6 (3.5)  | –            |
| Sheep   | 125             | 16 (12.8)   | 6 (4.8)   | 2 (1.6)     | 3 (2.4)  | –            |
| Cattle  | 88              | 12 (13.64)  | 11 (12.5) | 4 (1.04)    | 5 (5.68) | 9 (10.23)    |
| Total   | 384             | 58 (15.1)   | 26 (6.77) | 11 (2.86)   | 14 (3.65)| 9 (2.34)     |

TABLE 6  Frequency of identified FBs in association with the site of the fore stomach

| Identified Foreign Bodies | Location Rumen (%) | Reticulum (%) | Total | $\chi^2$ | p-value |
|--------------------------|--------------------|---------------|-------|----------|---------|
| Plastic                  | 55 (46.61)         | 3 (2.54)      | 58    | 374.64   | 0.00    |
| Cloth                    | 26 (22.03)         | –             | 26    |          |         |
| Leather                  | 11 (9.32)          | –             | 11    |          |         |
| Sack                     | 10 (8.47)          | 4 (3.39)      | 14    |          |         |
| Metallic                 | –                  | 9 (7.62)      | 9     |          |         |
| No FBs                   | –                  | –             | 266   |          |         |
| Total                    | 102 (86.44)        | 16 (13.56)    | 384   |          |         |

difference ($\chi^2 = 374.64, p = 0.00)$. In contrast, metallic, 7.62% (9/118), was the most frequently identified foreign bodies in the reticulum, followed by sack 3.39% (4/118) and plastic 3.54% (3/118; Table 6).

4  | DISCUSSION

In the current study, the overall prevalence of indigestible foreign bodies in different domestic ruminants was recorded to be 30.73% (118/384). This finding was higher than the studies reported by Tesfaye, Daba, et al. (2012) and Tesfaye, Yismaw, and Demissie (2012), 23.9%; Desiye and Mersha (2012), 13.22% and Roman and Hiwot (2010), 9.2%, in different parts of Ethiopia but lower than reports by Negash et al. (2015). These regional variations in the distribution of foreign bodies may be due to differences in animal management setup and the origin of animals presented for slaughter and the presence of negligent disposal of less biodegradable wastes like plastics, as well as lack of mineral and vitamin supplementation, especially during less available feedstuffs such as the dry season. Similarly, in Ethiopia, there is a feed scarcity, particularly during the prolonged dry season, and most small ruminant owners do not provide extra feed to their animals.

The occurrence of foreign bodies among goats (35.88%), sheep (27.27%) and cattle (21.51%) was found statistically non-significant. These findings disagreed with the report of Roman and Hiwot (2010), who reported 41.8% (167/400) in cattle, 20.6% (66/320) in sheep and 11.9% (38/320) in goats. In the current study, the highest record of indigestible foreign bodies was plastics (43.98%) in different stomach compartments of animals. This finding was in line with several findings from another nearby region of Ethiopia (Abebe & Nuru, 2011; Roman & Hiwot, 2010; Tesfaye, Yismaw, & Demissie, 2012), Nigeria (Nongcula et al., 2017; Remi-Adewunmi et al., 2004). This may be due to less biodegradability of the synthetic plastic materials, negligent disposal and less availability of industry for recycling in the study areas.
In this particular study, the highest prevalence of various indigestible foreign bodies was detected in aged (39.3%) animals’ rumen and reticulum. This finding agrees with the reports of Abebe & Nuru, 2011 on sheep and goats, which may be due to the progressive accumulation of indigestible consumed items over a long period. In addition, indigestible foreign bodies were found in poor body condition (38.98%), followed by medium (31.62%) and good body condition scores (27.88%). This finding also agrees with Rahel (2011), who reported that animals in poor body condition had a greater rate of incidence. The poor bodily condition might be attributed to the presence of a foreign body that interferes with the absorption of volatile fatty acids and effective feed conversion. In the study, higher foreign bodies were found in the rumen (86.43%) than in the reticulum (13.56%) in all ruminants with a statistically significant difference ($p < 0.05$). These findings were also highly consistent with the findings of Roman and Hiwot (2010), Negash et al. (2015), Abebe and Nuru (2011) and Tesfaye, Yismaw, and Demissie (2012). This may be due to the greater rumen capacity, the cumulative size and material composition of the foreign items, and the different sorts of material might all be factors.

The most common foreign bodies found in the reticulum were metallic 7.63% (9/118). This in turn might be due to the honeycomb structure of the reticulum mucosa, which can retain the foreign material along with their substantial weight that allows them to be drawn by the permeability of the reticulum due to the gravitational pull force of these heavy foreign items to the ventral portion of the forestomach. The data that support the findings of this study are available from the corresponding author upon reasonable request.

### AUTHOR CONTRIBUTIONS

All authors contributed to the manuscript to the final submission. Conceptualisation, data curation, analysis and writing the original draft were performed by A.L. Duresa. Investigation, methodology, validation and supervision were majorly done by D.J. Kitessa while visualisation, reviewing and editing were done by T.Ch. Feyissa. Finally, all authors read and approved the final manuscript submission.

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### CONFLICT OF INTEREST

The authors declare that the manuscript has no competing interest to declare that is relevant to the content of this article.

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### ETHICS STATEMENT

Ethics approval was obtained from the Addis Ababa University, College of Veterinary Medicine and Agriculture Animal Research Ethics Review Committee. Thus, the authors declare that all methods were performed following the relevant guidelines and regulations.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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### PEER REVIEW

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